5.3 Water Environment

(1) Scarcity and Degradation of Freshwater in Egypt

The water resources of Egypt could be divided into two systems; the Nile system and the groundwater system in desert area. The Nile system consisting of the Nile River, its branches, the irrigation canals, the agricultural drains and the valley and Delta aquifers. These water resources are interconnected. This system is replenished yearly with approximately 58.5 billion m^3 of freshwater, as is given in the survey by MWRI. Egypt depends on the Nile for almost all of water resources; naturally, it is a crucial issue on how to preserve water quality of the River Nile. On the other hand, water in desert area is in deep sandstone aquifer and is generally non-renewable source, though considerable amounts of water are stored in the groundwater system.

Table 5.13: Water Balance of the River Nile

Items	Water balance (billion m^3/yr)	
	Inflow	Outflow & use
HAD release	55.50	
Effective rainfall	1.00	
Sea water intrusion	2.00	
Total inflow	58.50	
Consumptive use agriculture		40.82
Consumptive use industries		0.91
Consumptive use domestic		0.45
Evaporation		3.00
Total use and evaporation		45.18
Navigation fresh water		0.26
Fayoum terminal drainage		0.65
Delta drainage to the sea		12.41
Total outflow		13.31

Source: MWRI

Water demand in Egypt has been increasing due to population growth, higher standard of living, reclaiming new land, and advancing industrialization. Available water per capita per year for all purpose in 1999 was about 900m^3; nonetheless, it is expected to fall to 670m^3 and 536m^3 by the years 2017 and 2025, respectively. A major challenge facing Egypt today is to manage escalating demand for water from growing population and industrialization.

Table 5.14: National Water Resource Utilization and Development Plan

		Unit	2000		2017	
			Value	Ratio	Value	Ratio
Condition	Population	1,000 people	68,166		89,000	
	Irrigated area	Fadden*	8,167,723		12,000,000	
Water resource	The Nile river	Billion m^3/yr	55.50	82.3	64.50	76.4
	Flood discharge	Billion m^3/yr	1.00	1.5	1.0	1.2
	Groundwater (Sinai)	Billion m^3/yr	0.50	0.7	0.50	0.6
	Groundwater (Delta)	Billion m^3/yr	4.80	7.1	7.50	8.9
	Reuse of irrigation water	Billion m^3/yr	4.90	7.3	8.40	10.0
	Reuse of treated water	Billion m^3/yr	0.70	1.0	2.50	3.0
	Total	Billion m^3/yr	67.40	100.0	84.40	100.0
Water utiliza-tion	Irrigation water	Billion m^3/yr	50.66	75.2	60.0	71.1
	Domestic water	Billion m^3/yr	3.94	5.8	8.80	10.4
	Industrial water	Billion m^3/yr	5.90	8.8	12.50	14.8
	River navigation and river mouth outflow	Billion m^3/yr	6.90	10.2	3.10	3.7
	Total	Billion m^3/yr	67.40	100.0	84.40	100.0
	Daily life water per capita	L/day, capita	158		270	

1 Fadden: 0.42 ha

Source: JICA, "Basic design study report on the project for water supply development in northwest part of Sharqiya Governorate in the Arab Republic of Egypt", Sep. 2003

The Ministry of Water Resources and Irrigation monitors and evaluate freshwater quality including that of groundwater. The quality of the River Nile depends primarily on the water quality of Lake Nasser and to some extent and the upper reaches of the Nile. Downstream changes in river water quality occur due to followings:

1. The hydrodynamic regime of the river regulated by different barrages,
2. The water quality of agricultural return flows,
3. Domestic and industrial wastewater discharges.

Individual pollution sources and conditions of water pollutions are described below.

(2) Sewage Treatment

1) Sewage Treatment in Rural Area

An estimated 10 million cubic meters of domestic wastewater is generated by all governorates per day, in which approximately 1.6 billion cubic meters/year receives treatment. Access to sewerage systems is predominantly in urban areas, with about 77% of the population of Cairo connected to sewage collection networks. In rural areas, where about half of the population reside (35 million people), 95% of the people have no access to sewer systems or wastewater treatment facilities.

Table 5.15: Water Supply and Sanitation Coverage across Egypt

Governorates	Population (1,000)	Population connected to public network (%)	
		Water	Sanitation
Cairo	6,810	80.49	75.03
Alexandria	3,339	90.03	60.56
Port Said	472	89.42	41.83
Suez	418	63.24	89.38
Urban Sub-total	11,030	80.42	66.60
Damietta	914	88.94	45.87
Daqahlia	4,224	77.89	44.43
Sharqia	4,281	54.00	28.96
Qalybia	3,301	54.54	22.46
Kafr-El-Sheikh	2,224	66.89	16.01
Gharbia	3,406	69.34	18.33
Menofia	2,706	52.69	6.03
Behira	3,994	51.60	10.88
Ismalia	715	57.63	23.97
Lower Egypt Sub-total	25,819	62.52	23.50
Giza	4,784	71.05	39.14
Beni Suef	1,859	38.35	4.71
Faiyum	1,990	49.37	12.07
Minya	3,310	31.99	2.95
Asyut	2,802	49.74	3.90
Sohag	3,123	45.67	4.38
Qena	2,442	43.71	4.00
Aswan	974	41.61	6.88
Luxor	361	55.47	9.10
Upper Egypt Sub-total	21,646	37.27	9.98
Red Sea	157	46.57	9.92
New Valley	142	80.34	68.60
Matrohh	212	54.52	12.45
North Sinai	252	74.54	22.08
South Sinai	55	33.61	24.75
Frontier Sub-total	818	62.15	26.48
Total	59,313	59.75	26.25

Source: EcoConServ, 'The Study on Status of the Environment and Relevant Policies/Measures in Egypt', 2005

In rural areas, septic tanks are mostly used, and the wastewater is partially cleaned. In the rural areas of the Nile Delta, where high population densities exist along with high groundwater table, serious health risks arise from this practice, as the not-fully treated wastewater seeps into the ground and contaminate the groundwater. Raw sewage is also discharged into the agricultural drains in Upper Egypt. All drains flow back into the Nile. In areas, where wastewater treatment facilities exist, the flows of municipal wastewaters greatly exceed the design capacity of the plants and this overload results in a poor effluent quality. This, in turn, further degrades the water quality in the agricultural drains. As such, mixing drainage water with the freshwater for irrigation purposes brings concern to the use of this water public health.

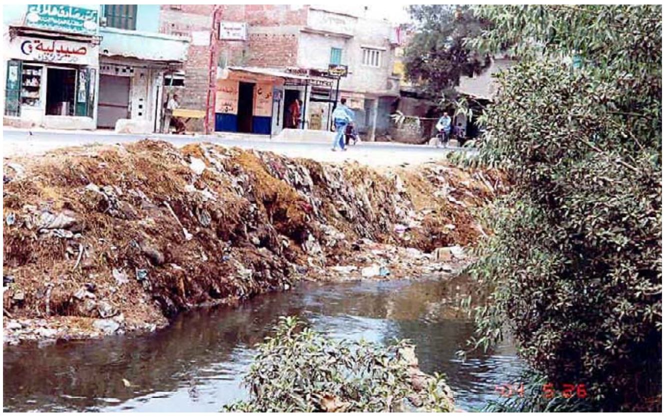

Photo 5.14: Canal Polluted with Solid Waste

2) Sewage Treatment in Urban Area

Many wastewater collection networks in urban areas, especially in Cairo, serve industries and commercial activities, which bring high levels of potentially toxic substances, such as heavy metals and organic pollutants. These elements become concentrated in the sewage sludge, which also produces a problem for the safe disposal and/ or reuse of this sludge. According to National Water Resources Plan, 2002, an additional capacity of treatment plants equivalent to 1.7 BCM is targeted by the year 2017. Although the capacity increase is significant, it will not be sufficient to cope with the future increase in wastewater production from municipal sources and therefore, the untreated loads that will reach water bodies are not expected to decline.

Table 5.16: Projections of Wastewater Treatment Coverage

Year	Population	People Serves	People Not Served
1997	60 Million	18 Million	42 Million
2017	83 Million	39 Million	44 Million

Source: EcoConServ, 'Study on Status of the Environment and Relevant Policies/Measures in Egypt', Feb. 2005

Table 5.17: Design Capacity and Actual Treatment Amount of Sewage Plant in Each Governorate in 2002

Governorates	Actual sewages (unit: 1,000m^3)	Average capacity (unit: 100m^3/hr)	Design capacity (unit: 100m^3/hr)
Beni-Suef	756	5	6
Fayoum	10,389	15	16
Menia	20,867	93	131
Asyout	9,947	123	157
Suhag	10,870	64	99
Qena	357,318	426	836
Aswan	26,820	718	1,122
Luxur	41,300	540	740
ElWadi ElGidid	8,340	12	17
Matrouh	475	13	69
North Sinai	31,098	43	80
South Sinai	3,587	11	61
Cairo	1,903,293	2354	2,989
Alexandria	2,552,102	2508	6117
Port-Said	36,606	611	687
Suez	606,587	2,920	4,340
Damietta	66,547	88	88
Dakahlia	226,886	345	1,075
Sharkia	77,899	4,868	5,187
Kalyoubia	96,540	1,850	2,027
Kafr-ElSheikh	72,738	804	823
Gharbia	84,435	2,906	8,530
Menoufia	384,143	632	1,613
Behera	335,574	655	1,525
Ismailia	21,883	335	672
Giza	46,415	1,337	13,828
Total	6,511,648	22,213	49,501

Note: The statement include only main stations, exclude the sub stations which pump water to main stations.
Source: Arab Republic of Egypt Central Agency for Public Mobilisation and Statistics, 'the Statistical Year Book 1995-2003', June 2004

The study team visited a sewage treatment plant that was built with the support from USAID. The station adopts activated sludge process and treats 2,350m^3/day, BOD 500mg/L before treatment and BOD50 mg/L after the treatment. Excess sludge was dumped to neighboring MSW landfill site. The interview survey revealed that there were many sewage treatment plants that simply treat the wastewater with sedimentation and aerobic- anaerobic lagoon using commodious land, and do not meet effluent standards. It is easily recognizable to see the poor condition of drainage canals in urban area, like Giza, where wastewater is contaminated with organic and/or humin matters and turned to black. Development of sewage system in urban and suburban areas, as well as simple and low-cost treatment facility for night soil and domestic wastewater in rural area should be promoted and disseminated in Egypt.

(3) Urban Sewage, Industrial Effluent, and Groundwater

1) Municipal Wastewater

Of the sources of pollution to the River Nile, discharge of raw sewage, especially in the rural areas is the most critical. Most waterways receive raw sewage either directly from housing units or sewage/ sludge emptying trucks.

Photo 5.15: Water Pollution Status of Canal in Cairo

2) Industrial Wastewater

There are estimated to be some 24,000 industrial enterprises in Egypt, of which about 700 are major industrial facilities. In general, the majority of heavy industry is concentrated in Greater Cairo and Alexandria. Approximately 387 million cubic meters of industrial effluents are discharged to the Nile, its canals and drains. Some 34 large industrial facilities discharge into the Nile between Aswan and Cairo. However, ten of these facilities still were not in compliance with some of the effluent concentration discharge standards set in Law 48/1982 (seeTable 5.18). By directing industrial discharges to the sewerage networks, municipal wastewater treatment plants would be overloaded and their efficiency would be reduced.

Table 5.18: Effluent Quality from Major Industries Discharging to the Nile

	Law 48 limits & recorded discharges levels (exceeded standards in bold)								
Source of Pollution	pH (6-9)	BOD 30 mg/L	COD 40 mg/L	TDS 1,200 mg/L	TSS 30 mg/L	Oil & Grease 5mg/L	Nitrate 30 mg/L	In-organ Phosp. 1 mg/L	Fe 1 mg/L
Kima Factory (Aswan)	**9.4**	4	55	**1,920**	15	**6.4**	**450**	0.20	0.11

	Law 48 limits & recorded discharges levels (exceeded standards in bold)								
Source of Pollution	pH (6-9)	BOD 30 mg/L	COD 40 mg/L	TDS 1,200 mg/L	TSS 30 mg/L	Oil & Grease 5mg/L	Nitrate 30 mg/L	In-organ Phosp. 1 mg/L	Fe 1 mg/L
Kom Imbou Sugar Factory	5.7	**83**	**657**	410	**67**	**9.3**	2.1	0.06	0,85
Idfou-1 Sugar Factory	**9.3**	**410**	**1,440**	365	**65**	**5.6**	2.2	0.04	0.23
Idfou-2 Sugar Factory	5.2	**81**	**600**	225	**42**	**5.6**	1.3	0.04	0.74
Qous Sugar Factory	7.5	77	**189**	240	22	--	1.0	0.15	0.40
Sohag Oil Factory	7.6	8.5	33	**1,374**	**145**	**7.3**	3.5	0.04	0.39
Coca Cola Bottling Factory	**11.3**	**83**	**256**	737	**39**	**5.9**	3.5	0.14	0.27
Elhwamdia Sugar Factory	1.1	**440**	**3,850**	**8,192**	**60**	**17.6**	10	**7.50**	--
Salt and Soda Factory	--	**130**	**155**	--	**387**	**9.4**	--	--	--
Talkha Fertilizer Factory	**10.2**	**98**	**204**	**1,350**	**67**	**7.6**	**128**	--	--

Notes: dash (--) indicates information not available.
Source: Ministry of Water Resources & Irrigation, Data as of February 2000

3) Groundwater

Ministry of Water Resources and Irrigation developed underground water quality monitoring network with the support of the government of Netherlands. According to this network, high concentration of TDS, sulfate group and nitric were found from the groundwater in landfill sites in the Nile Delta. In addition, salinity of this groundwater is high, and there is an indication of spread of this contaminated groundwater to another area of the central region. Quality of groundwater in central Delta, Nile Valley and desert area are not deteriorated.

However, in case of groundwater pollution, flux and diffusion velocity of pollutant are extremely slow comparing to surface water. If hazardous groundwater contamination were found in wide-area monitoring, it is easily anticipated that the contamination would have been widely spread already. Once groundwater is contaminated, it is not practical to expect natural mechanism would cleanup the pollution. Also, in case of soil and groundwater contamination, restoration effort requires tremendous amounts of money and time. Therefore, in case of groundwater pollution, wide-area monitoring is necessary but it is also important, in a future, to monitor particular hazardous substances in areas anticipated contamination. Pollution caused by hazardous substances, like chlorinated organic solvent, and groundwater pollution around waste management facilities in industrial area should be particularly paid attention. The monitoring of hazardous pollutants has not been implemented in full scale according to Groundwater Research Institute.

(4) Agricultural Drainage

1) Water Contamination in Agricultural Drainage Canals

Throughout Egypt, the course of irrigation and drainage canals is a total of approximately 55,000 km. Degradation of water quality in the Nile River and associated irrigation and drainage canals is a major issue in Egypt. Various agencies and ministries undertake water quality monitoring of the Nile River and associated irrigation and drainage canals. Each monitoring program has different objectives, different sampling locations and covers different water quality parameters. Furthermore, most of these monitoring activities are not conducted on a regular basis. Also, there are many gaps in geographical coverage, with the main Nile River receiving the most attention. Monitoring of the canals has only recently been included in the monitoring programs and information about water quality along the length of drains in Upper Egypt is very limited. Most water quality monitoring programs focus on conventional parameters and limited data is available on important parameters such as pesticides, heavy metals and hydrocarbons.
Pollutants included not only agricultural wastewater alone but also industrial wastewater and municipal wastewater as well.

Photo 5.16: Agricultural Drain Polluted with Solid Wastes, Sewage and Dead Animals

Being the largest consumer of water, agriculture is also a contributor to water pollution. Drainage water seeping from agriculture fields is considered a non-point source of pollution.

The water is collected and concentrated in agricultural drains and pollutes the River Nile, the Northern Lakes, and irrigates canals in case of mixing water for reuse. Moreover, these non-point sources of pollution may also influence the groundwater quality. Major pollutants in agricultural drains are salts; nutrients (phosphorus & nitrogen); pesticide residues (from irrigated fields), pathogens (from domestic wastewater), and toxic organic and inorganic matters (from domestic and industrial sources).

The Egyptian Public Authority for Drainage Projects (EPADP) is responsible for the improvement and maintenance of land drainage networks in the agricultural lands of Egypt. It has the following tasks:

- Determine the desired water table conditions that permit an optimum crop production;
- Identify areas where poor drainage conditions limit crop production;
- Design, install, operate and maintain drainage systems for these areas according to a set of design criteria that prescribe effective and efficient water table control;
- Transfer ownership and responsibilities to the system users, i.e. the farmers

EPADP has installed sub-surface and surface drainage systems to reduce water-logging (high water table) and prevent salinization of agricultural lands. The provision of over 2.5 million hectares with drainage systems was started in 1973 and expected to complete in 2010.

2) Water Quality in Agricultural Drains in Upper Egypt

According to a recent survey of water quality in the Nile River system in Egypt carried out by the USAID funded Agricultural Policy Reform Program, there are 67 agricultural drains discharging into the Nile River in Upper Egypt (from Aswan to the Delta Barrage). The data indicates that out of the 43 major drains in Upper Egypt, only 10 are in compliance with the standards set by Law 48/1982 (Article 65) regulating the quality of drainage water which can be mixed with fresh water. Table 5.19 shows the water quality of 43 points of agricultural drains and Table 5.20 shows the organic loads (COD load, BOD load) and inorganic loads. In terms of organic load, it was found that the highest organic load was discharged from Com Ombo drain (21.8 ton COD/day, 5.97 ton BOD/day). This is followed by El-Berba drain (17.3 ton COD/day; 6.5 ton BOD/day). It is worth mentioning that these two drains contribute 76% of the total organic load (calculated as COD) discharged into the Nile by drains from Aswan to Delta Barrage.[1]

Table 5.19: Water Quality of Agricultural Drains in Upper Egypt

[1] Calculation based on data shown in Table 5.19 will indicates the highest COD / BOD value in Esta; however, it is most likely the calculation made in the referred data (from USAID) was wrong. According to EcoConServ, discharge at Com Ombo may be 1.4 million m^3/day, instead of 0.14 million m^3/day.

No.	Drain name	Location (km)	Discharge mm^3/day	COD mg /l	BOD mg /l	DO mg/l	TDS mg/l	FC MPN/100ml	Heavy Metals mg/l
	Consent standard			15 mg/l	10 mg/l	5 mgO_2/l	500 mg/l	5.00E+03	3 mg/l
1	Khour El sail Aswan	9.9	0.10	102	32.80	1.91	1190	3.25E+04	0.31
2	El Tawansa	37.3	0.01	8	1.01	6.16	710	3.50E+03	0.50
3	El Ghaba	46.6	0.19	11	1.00	7.8	570	1.85E+03	0.75
4	Abu Wanass	47.2	0.20	7	1.28	7.03	463	3.00E+03	0.39
5	Main Draw	48.9	40 l/s	17	1.48	7.34	460	3.00E+04	0.61
6	El Berba	49.1	0.15	113	42.70	3.85	414	2.25E+04	0.70
7	Com Ombo	51.0	0.14	151.6	41.50	2.25	325	2.25E+04	2.15
8	Menaha	55.0	-	4	1.52	7.86	285	7.50E+03	0.26
9	Main Ekleet	57.0	0.02	4	1.53	9.21	340	1.50E+03	2.44
10	El Raghama	64.7	0.04	10	1.55	8.56	390	1.75E+03	0.30
11	Fatera	70.5	0.78	5	2.04	7.7	564	3.50E+03	0.54
12	Khour El sail	70.8	0.17	2	1.05	9.07	500	2.00E+03	0.34
13	Selsela	73.9	50 l/s	3	1.25	6.38	380	3.20E+03	1.26
14	Radisia	99.9	0.13	16	3.06	9.02	1430	2.30E+03	0.22
15	Edfu	116.2	0.27	15	1.59	9.49	817	3.00E+03	2.37
16	Houd El Sebaia	139.5	0.05	16	1.83	6.77	495	1.75E+04	0.76
17	Hegr El Sebaia	149.1	0.05	19	2.55	7.82	670	4.50E+03	0.51
18	Mataana	187.7	0.12	39	3.15	6.45	613	1.75E+04	1.29
19	El Zeinia	236.0	NA	NA	NA	*	*	*	NA
20	Habil El Sharky	237.7	0.08	30	1.78	8.45	560	4.00E+02	1.06
21	Danfik	251.6	0.01	34	2.52	8.51	367	1.50E+03	1.05
22	Sheikia	265.3	0.06	37	1.72	7.55	662	3.75E+03	4.68
23	El Ballas	270.7	0.01	144	10.78	9.17	1395	1.50E+04	0.59
24	Qift	275.9	0.03	30	1.60	9.11	375	2.50E+03	0.39
25	Hamed	331.2	0.07	11	1.00	7.18	1015	9.00E+02	0.35
26	Magrour Hoe	340.4	0.06	21	3.24	8.2	185	1.60E+03	1.05
27	Naga Hammadie	377.8	0.21	13	2.17	8.11	375	3.30E+03	1.67
28	Mazata	392.8	0.01	10	2.19	8.37	495	2.50E+02	0.23
29	Essawia	432.7	0.07	9	2.43	6.61	200	1.50E+03	0.51
30	Souhag	444.6	0.05	9	2.81	7.42	440	8.00E+02	0.38
31	Tahta	486.4	0.01	21	2.01	7.86	980	1.40E+03	0.29
32	El Badary	525.4	0.12	6	3.27	7.25	255	9.00E+02	0.48
33	Bany Shaker	588.6	0.02	13	2.25	7.47	485	1.00E+04	0.30
34	El Rayamoun	637.4	NA	21	15.85	2.77	290	1.50E+03	0.16
35	Etsa	701.2	0.57	100	38.00	1.58	575	3.50E+04	0.19
36	Absoug	780.5	0.19	29	1.89	7.34	640	3.00E+03	0.34
37	Ahnasia	807.2	0.54	14	1.31	7.08	610	3.75E+03	0.26
38	El Saff	871.3	NA	NA	NA	*	*	*	NA
39	El Massanda	879.6	0.14	45	4.99	5.57	715	3.00E+03	0.19
40	Ghamaza El	884.5	0.06	42	2.52	6.37	235	9.50E+02	0.46

No.	Drain name	Location (km)	Discharge mm^3/day	COD mg /l	BOD mg /l	DO mg/l	TDS mg/l	FC MPN/100ml	Heavy Metals
	Consent standard			15 mg/l	10 mg/l	5 mgO_2/l	500 mg/l	5.00E+03	3 mg/l
	Soghra								
41	Ghamaza El Kobra	885.0	0.05	32	3.79	7.39	290	7.50E+02	0.28
42	El Tibeen	898.1	0.02	25	15.20	3.71	840	3.25E+04	0.39
43	Khour Sail Badrashin	910.2	NA	NA	NA	*	*	*	NA

Note: FC=number of fecal coliforms, ＊: unknown

Source: based on EcoConServ, "Study on Status of the Environment and Relevant Policies/Measures in Egypt", 2005

Table 5.20: Loads of Organic and Inorganic Pollutants Discharged into the Nile from Upper Egypt Drains

No.	Drain name	Location (km)	Discharge $1000m^3$/day	COD (kg /day)	BOD (kg/day)	Heavy metals (kg/day)
1	Khour El sail Aswan	9.9	98.84	1,008.14	324.19	30.33
2	El Tawansa	37.25	6.48	5.19	0.66	3.25
3	El Ghaba	46.55	194.09	213.50	19.41	146.34
4	Abu Wanass	47.15	199.06	139.34	25.48	78.33
5	Main Draw	48.85	3.46	5.88	0.52	2.11
6	El Berba	49.1	152.82	17,268.66	6,525.41	107.20
7	Com Ombo	51	143.87	21,809.93	5,970.40	309.12
8	Menaha	55	NA	NA	NA	NA
9	Main Ekleet	57	20.17	8.07	3.09	49.17
10	El Raghama	64.65	44.71	44.71	6.93	13.35
11	Fatera	70.45	779.49	389.75	159.02	418.20
12	Khour El sail	70.75	170.39	34.08	17.89	58.02
13	Selsela	73.85	4.32	1.30	0.54	5.45
14	Radisia	99.85	130.7	209.12	39.99	29.08
15	Edfu	116.2	268.9	403.35	42.76	637.43
16	Houd El Sebaia	139.5	48.99	78.38	8.97	37.26
17	Hegr El Sebaia	149.1	49.54	94.13	12.63	25.24
18	Mataana	187.7	122.50	477.75	38.59	158.21
19	El Zeinia	236	NA	NA	NA	NA
20	Habil El Sharky	237.7	79.12	237.36	14.08	84.22
21	Danfik	251.55	8.22	27.96	2.07	8.66
22	Sheikia	265.3	59.83	221.37	10.29	279.79
23	El Ballas	270.7	6.38	91.92	6.88	3.79
24	Qift	275.9	32.64	97.91	5.22	12.74
25	Hamed	331.2	67.07	73.78	6.71	23.24
26	Magrour Hoe	340.35	58.71	123.29	19.02	61.50
27	Naga Hammadie	377.8	214.9	279.37	46.63	359.21
28	Mazata	392.75	5.87	5.87	1.29	1.33
29	Essawia	432.7	74.20	66.78	18.03	37.732
30	Souhag	444.55	47.5	42.75	13.35	18.26

No.	Drain name	Location (km)	Discharge $1000m^3$/day	COD (kg /day)	BOD (kg/day)	Heavy metals (kg/day)
31	Tahta	486.4	6.28	13.18	1.26	1.83
32	El Badary	525.4	119.94	71.96	39.22	57.03
33	Bany Shaker	588.6	19.60	25.48	4.41	5.97
34	El Rayamoun	637.4	NA	NA	NA	NA
35	Etsa	701.15	567.98	5,679.76	2,158.31	105.36
36	Absoug	780.5	194.39	563.72	36.74	66.97
37	Ahnasia	807.2	541.65	758.31	70.96	138.93
38	El Saff	871.3	NA	NA	NA	NA
39	El Massanda	879.6	141.48	636.66	70.60	26.24
40	Ghamaza El Soghra	884.5	59.62	250.39	15.02	27.21
41	Ghamaza El Kobra	884.95	48.04	153.72	18.21	13.62
42	El Tibeen	898.1	20.17	50.43	30.66	7.80
43	Khour Sail Badrashin	910.15	NA	NA	NA	NA
Total			0	51,663.21	15,785.41	3,449.52

Source: Data from EcoConServ, "Study on Status of the Environment and Relevant Policies/Measures in Egypt", 2005

3) Water Quality of Agricultural Drain in the Delta Region

Delta drains receive discharge from predominantly untreated or poorly treated wastewater (domestic & industrial), as well as drainage of agricultural areas. Furthermore the drainage water in the Delta region is becoming more saline; on average its salinity increased from 2,400 g/m^3 in 1985 to 2,750 g/m^3 in 1995. The salinity concentrations also exhibit an increasing trend in a northwards direction. For example, in the southern part of the Nile Delta drainage water has salinity between 750 and 1,000 g/m^3, whereas the salinity in the middle parts of the Delta reaches about 2,000 g/m^3 and in the northern parts between 3500 and 6000 g/m^3. In a recent study published by the Drainage Research Institute (2000), it has been estimated that the Delta and Fayoum drains receive about 13.5 billion cubic meters of wastewaters per year. Almost 90% of which is contributed from agricultural diffuse source, 6.2% from domestic point sources, 3.5% from domestic diffuse sources and the rest (3.5%) from industrial point sources. It was also found that Bahr El-Baqar drain received the greatest amount of waste water (about 3 billion cubic meters/year). In terms of organic loads, as expressed by COD and BOD values, Bahr El-Baqar drain also receives the highest load. See Annex (Chap. 5.1.3, pp36) for the water quality of major drainages.

Table 5.21: Breakdown of Inflow into Agricultural Drainages in the Delta Area

Unit: (1,000m^3/day)

Drain	Domestic Point sourcees	Industrial Point Sources	Domestic Diffuse sources	Agricultural Diffuse sources	Total
Bahr El-Baqar	184	64	123	4,522	6,549
Bahr Hados	80	6	208	4,836	5,130
Faraskour	2	0	13	187	203
El-Serw El-Asfal	8	0	19	509	535
El-Gharbia Main	157	44	293	3,928	4,422
Tala	0	0	45	1,087	1,134
Sabal	79	0	40	1,196	1,315
No. 8	0	0	42	470	512
Bahr Nashart	22	14	109	969	1,114
No. 7	13	0	40	390	442
No. 1	39	21	78	1,205	1,343
No. 9	0	0	88	596	684
Zaghloul	0	0	2	123	125
Edko	20	7	57	4,232	4,317
Borg Rashid	0	0	0	311	311
El-Umoum	25	0	82	5,163	5,270
Abu-Keer	0	23	16	622	660
El-Batts	22	0	26	1,468	1,517
El-Wadi	3	0	13	1,600	1,617
Total (m^3/day)	2,312	180	1,295	33,413	37,200
Total (Billion m^3/year)	0.84	0.066	0.47	12.2	13.6
% Ratio	6.20%	0.50%	3.50%	89.70%	

Canal Operation

Photo 5.17: Pump Station at Alexandria

In Egypt, there are 32 pump stations centering on the Delta area. Eight stations are forced to stop their operation because of water quality degradation caused by inflow of untreated domestic wastewater, factory effluent, agricultural wastewater and solid waste dumping.

Photo 5.18: Dragged Material Containing Municipal Waste in Canal at Alexandria

Although canals are dredged periodically, sediments and waste after dredging are piled around canals (right photo). The dredged sediments and wastes are back into the canal after awhile (left photo). These scenes are seen in water supply, drainage and agricultural canal.

(5) Pollution in Brackish–Water Lake in Northern Delta

Four coastal lagoons fringe the North coast of the Nile Delta area in Egypt: Lake Manzala, Lake Mariout, Lake Edku and Lake Burullus. One further lake also borders the Mediterranean Sea in the North of Egypt, Lake Bardawil in the Sinai Peninsula. The environmental quality of Lake Bardawil, which is a Ramsar site is considered to be pristine. The other four lakes on the North coast of Egypt, however, suffer from a great deal of environmental pressures.

Figure 5.7: Location of Brackish-Water Lakes

- <u>Lake Manzala</u>

  Lake Manzala is located on the northeastern edge of the Nile Delta, separated from the Mediterranean Sea by a sandy beach ridge. The two water bodies are connected at three points, allowing for some water exchange. The lake is large, shallow, and brackish and exposed to high levels of pollutants from industrial, domestic, and agricultural sources. The Bahr El Baqar drain transports water from eastern Cairo for 170 kilometers to the lake, carrying large amounts of particulate matter, nutrients, bacteria, heavy metals, and toxic organics. Methane and hydrogen sulphide bubble up to the surface, releasing greenhouse gases.

  Fish production overall is high and once supplied 30 percent of Egypt’s total catch. In recent years, however, Lake Manzala’s fish have had a reputation for being chemically and microbially contaminated. Tainted drinking water from the lake leads to enteric diseases. Fish and bird species have substantially declined in the area. Land reclamation has also reduced the lake surface by half, and, despite declining quality of life and standards of living near the lake, human populations are increasing, exacerbating the lake’s problems.

- <u>Lake Mariout</u>

Composed of five main basins separated by sand banks, with an approximate total area of 17,000 feddans, Lake Mariout is the smallest of the Northern lakes. It is also considered to be the most polluted. Also, being approximately 20 meters away from the Mediterranean Sea, it does not have a direct discharge point out to sea to aid in its purification. The depth of the water in Lake Mariout ranges between 3-5 meters. The only discharge point from the lake is through the Mex pumping station, which regulates the water level in the lake (2.2-2.4 meters above sea level).

Agricultural drains are the major sources of water for the lake but the effluents from a petroleum refinery and a number of other industries also directly discharge their effluents into the lake. The discharges to the lake may be divided agricultural drainage water from Omum drain (60%), agricultural drainage water from Nubariyah Canal (22%) and untreated industrial effluents and partially treated sewage (13%).

The next table shows the inflow water quality into the lake but harmful substance condition such as heavy metals are unknown. The lake sediments contain high levels of heavy metals. During the summer months, and especially in the eastern portion, the lake may exhibit anaerobic conditions resulting in emissions of noxious gases (ammonia and hydrogen sulphide).

Table 5.22: Water Quality of Lake Mariout

Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Standard according to Law 48/ 1982
Temperature (°C)	29.5	25.7	25.6	26	27.6	26.8	Not to exceed 5 ° C more than ambient (35°C)
Turbidity (NTU)	20	4	40	32	12	0	Maximum 50 NTU
pH	7.1	7.8	7.2	8.5	8.0	8.0	7.0-8.5
Salinity (%)	0.1	0.28	0.28	0.22	0.38	0.28	No standard
Dissolved Oxygen (mg/l)	0.5	0.5	3.1	6.9	6.8	8	Minimum 4 mg/l
COD (mg/l)	227	44	73	132	117	7.5	No standard
TDS (mg/l)	1,139	2,444	3,869	4,930	5,260	3,849	Maximum 650 mg/l

Key:

Sample 1: Basin 1 from in front of the discharge point of the Western wastewater treatment plant
Sample 2: Center of basin 1
Sample 3: Omum Drain
Sample 4: Center of basin 2
Sample 5: Navigational channel
Sample 6: Basin 3

- Lake Edku

Lake Edku lies 40 km east of Alexandria and 18 km west of Rosetta. It is a shallow (1.0-1.5 m depth) brackish water lake with one connection to the Mediterranean at El Meadia. The surface area of the lake has decreased considerably over the past century due development on the shallow areas of the lake, currently reaching 19-20,000 feddans from an original 51,000 at the end of the 19th century. Since the construction of the drainage network in the Beheira Governorate in the 1920's, the lake has become a repository for the waters emanating from the drainage of a catchment area of 200,000 feddans. The lake receives water from three drains along the southern and eastern sides. Seawater is primarily affecting the western side of the lake near the outlet. After construction of the Aswan High Dam, the annual drainage in the lake has increased.

The waters of Lake Edku are composed of 90% agricultural drainage water and 10% seawater. As a result of this the salinity of the lake has decreased considerably and this has led to significant changes in the biological and chemical characteristics of the lake. Agricultural drainage water is conveyed to the lake through three main drains: Edku Khairy drain, Tard El-Boseily drain and Tard Barseek drain. The drainage water is also polluted by untreated domestic and industrial wastewaters which ultimately reach the lake.

(6) Marine Pollution

1) Pollution of Red Sea, Suez Canal, Gulf of Suez and Gulf of Aqaba

a. Background

The Red Sea is a long, narrow body of water separating northeast Africa from the Arabian Peninsula. It is nearly 2,000 km of navigable waters connected at the south with the Indian Ocean, and joins the Mediterranean Sea at the north of the Gulf of Suez. The Red Sea is 1932 km long and averages 280 km in width, and is shared by Egypt, Sudan, Ethiopia, Republic of Yemen, Saudi Arabia, Jordan and Israel. It is a semi-enclosed, narrow water body with no river inputs. The area of the Red Sea is about 438 km^2 and its mean depth is 491 m. The deeper basin of the Red Sea is separated from the Gulf of Aden by shallow channel shoals about 100 m deep, off Hannish Island. The Red Sea and its gulfs, Gulf of Aqaba and Gulf of Suez, constitute a unique and valuable ecosystem. The Red Sea is valuable, not just as a unique environment, but as one of a high diversity, great scientific and ecological sensitivity and of great beauty and tourist-value. Their natural resources provide a substantial economic support for the region. The Red Sea resources contribute substantially to Egypt's economy, particularly in the areas of oil production, navigation, tourism and fisheries.

The Gulf of Aqaba in the northern Red Sea is a warm water body, approximately 180 km long and on average 8 km wide. It is a deep basin with narrow shelves, which comprises two isolated depressions separated by a submarine sill. The northern depression is about 1,100 m deep and the southern depression is about 1,420 m deep. The maximum depth within the Gulf of Aqaba is observed near the east coast with a depth of 1,829 m. The maximum depth within the Gulf of Aqaba is observed near the east coast with a depth of 1,829 m.

The Gulf of Aqaba is a marine environment enclosed by arid lands that experience extremes of temperature and exceedingly low levels of precipitation. These conditions have led to the evolution of unique, and hence internationally important, coral reef and marine ecosystems, which are particularly susceptible to damage from pollution or other forms of environmental impact. The Gulf of Aqaba also represents a natural resource of major economic significance to the four riparian countries (Egypt, Israel, Jordan, and Saudi Arabia) in terms of access to sea transportation and the development of tourism and other industries along its shores.

The Gulf of Suez is relatively shallow, with a maximum depth of about 64 m and has a relatively flat bottom. Hence, the Gulf spreads a shallow basin filled with the surface water of the Red Sea. The Gulf of Suez is the area the most at risk of pollution in the Red Sea, particularly oil pollution.

Photo 5.19: Oil Contamination in the Gulf of Suez

Sinai Peninsula is a strategic national security zone for Egypt. Sharm El-Sheikh area, located at the southern part of Sinai, was declared as a protected area because of the diversity of wildlife species and other available natural resources. Sharm El-Sheikh area is characterized by barren terrain with limited vegetation cover, diversity of landscapes, clear skies and clear water with shallow coral reef community. The entire Sinai region is deeply dissected by the river valleys (or wadis) that eroded at earlier geological periods. These river valleys break the surface of the plateau into series of detached massifs with a few oases scattered here and there. Oceanographic and meteorological conditions such as air temperature, winds, rainfall, tide, water movement, water temperature, salinity, dissolved oxygen, acidity/alkalinity or nutrients in the Gulf of Aqaba and Gulf of Suez is described in Chap.5.2 of Annex, (pp41-58).

b. Costal Zones and the Marine Environment Preservation System in Egypt

Tourism has been well developed in Egypt and accounts for nearly 12% of Egypt's GDP. In 2000, it was estimated that 5.5 million visitors spending nearly US$4.5 billion at upper Egypt area, Cairo or the Red Sea. Increase in the number of hotel rooms and resident population followed a similar trend. These tourism development at the Red Sea, the Gulf of Aquaba and Gulf of Suez have a great impact on the marine environment of around those areas.

The Table 5.23 covers affiliated institutions for coastal environment conservation in Egypt.

Table 5.23: Responsible Institutions of Coastal Environment Conservation of Egypt

Authority Affiliated/Agency	Costal Zone Responsibility
Shore Protection Authority (SPA)	● Shoreline protection and management ● Regulation activities within coastal setback areas in coordination with EEAA.
Minister of State for Environmental Affairs, Egyptian Environmental Affairs Agency（EEAA）	● Coordination of the CZM plan. ● Review and evaluation of EIA's ● Regulation activities within coastal setback area in coordination with SPA ● Implementing marine ambient water quality monitoring ● Enforcement for the provisions of law 4/1994, in coordination with Governorates ● Management of marine protected areas ● In coordination with other organizations, preparing oil spill contingency plans
Ministry of Tourism, Tourism Development Authority (TDA)	According to the provisions of law 7/1991 and the presidential decree 374/91: ● Preparation of tourism development plans and setting priorities for their implementation ● Preparation, review and evaluation of tourism development program and projects and monitoring their implementation ● Carrying out preliminary land allocation for tourism development projects ● Execution of infrastructure projects and developing infrastructure framework schemes for tourism development ● Participation in the EIA process as the Competent Administrative Authority
Ministry of Petroleum, Egyptian General Petroleum Corporation (EGPC)	● Exploration and concessions

Authority Affiliated/Agency	Costal Zone Responsibility
Local Administration Governorates	● Governorate development plan ● Coordination of environmental activities within Governorate ● Environmental inspection and enforcement in coordination with EEAA ● Participation in the EIA process as the Competent Administrative Authority
Ministry of Planning	● Integrated development plans for a number of coastal areas.

Source: Tarek M. Genena, 'A Consultant Report on the Country Environmental Analysis', Dec. 2003

2) Levels of Pollution

EEAA conducts regular monitoring of the coastal water quality through the Environmental Information and Monitoring Program (EIMP) with the support of The Danish Agency for Development Assistance (DANIDA). A total of five field-sampling studies are undertaken in the Red Sea coastal areas by the EIMP throughout 2003

a. Gulf of Suez

The marine environment of the Suez bay is subjected to mixed sources of pollution (industrial, agricultural and domestic sewage) through the direct discharge of El-Kabanon drain, which is considered the main industrial and sanitary drain. Approximately 120,000 m^3 /daily of sewage is dumped through El-Kabanon drain into the Suez Bay. The sewage discharged into the Suez Bay contains 93.76 ton/year of ammonia, 0.305 ton/year of nitrite, 0.397 ton/year of nitrate, 52.93 ton/year of inorganic phosphate, 0.409 ton/year of copper, 3.65 ton/year of zinc, and 0.120 ton/year of lead.

In the Gulf of Suez region, the Ras Gharib beach suffers from the highest levels of bacterial pollution. This is primarily due to the discharge of raw sewage from the city of Ras Gharib directly into the Gulf of Suez. Other locations with the Gulf of Suez where high levels of bacterial counts were identified include Kabanon beach (where the source of pollution is the discharge of wastes from the area's meat processing facility), Raks beach (source of pollution is nearby port) and Attaka port (where the primary source of pollution is the ship-building industry). Nutrient levels (ammonia, nitrate, phosphate and chlorophyll) were found to be highest in the area surrounding Suez city

Research was carried out on heavy metal pollution in Suez Bay, where the bay is subjected to industrial run-off from oil refineries, fertilizer plants, and power station in addition to sewage and garbage. The heavy metal concentrations ranged from 7.2 to 147.7μg/l for Zn, 10 to 62.6μg/l for Cu, 0.7 to 12.1μg/l for Pb and 0.01 to 1.27 μg/l for Cd, respectively. Adabiya station showed the highest values because of the various pollution sources discharged (i.e., harbours, sewage, and industrial drains), while in contrast the station of Ain Sokhna showed the lowest concentrations.

In the Suez area, investigating the possibility of using seaweed as an indicator for trace metals pollution was carried out in 2003. The study investigated the trace metals concentration within sediment, water, and seaweed. In water, the annual mean concentrations were 0.272, 0.166 and 0.438 ppb for dissolved, particulate, and total Cadmium (Cd), respectively. While in sediment the Cadmium concentration was 5.670 ppm. Lead (Pb) in water showed annual mean concentrations of 1.096, 2.085, and 3.181 ppb for dissolved, particulate, and total lead, respectively; while in sediment lead concentration was 29.748 ppm. The annual mean concentration of Copper (Cu) in water was 0.972, 0.782 and 1.561 ppb for dissolved, particulate, and total copper, respectively. The total annual mean concentration of copper in sediment was 8.785 ppm with the highest value being 10.454 and the lowest being 3.506 ppm. Finally the recorded Zinc (Zn) annual mean concentrations were 20.76, 258.54, and 279.30 for dissolved, particulate, and total zinc, respectively. The mean Zinc concentration in sediment was 22.771 ppm. The study concluded that sediment is highly polluted by cadmium and in less degree by lead. Also the metal concentrations correlated with industrial activities.

The Ain Sukhna area in the Gulf of Suez was also found to suffer from extensive chronic petroleum pollution inputs as it is evident in the vicinity of the SUMED pipeline company terminals, which include both floating and land-based receiving terminals.

In the Suez area, a study was carried out in 2003 to measure nutrient salts around the Suez Bay and down to Ain Sukhna area. Nitrate concentration ranged between 0.650μg at-N /l and 25.780μg at-N /l. The highest value of nitrate recorded was attributed to the fertilizer waste from El-Nasr fertilizer factory and sewage waste disposal from El-Kabanon drain. El-Nasr Factory produces 1500 ton/day of nitrate salt and discharges 14000m^3/ day of low saline wastewater. Nitrite concentration varied in water sea was between 0.150 – 3.740 μg at-N /l. The nitrite concentration recorded was higher than that recorded previously in 1999 (0.00- 2.90 μg at-N /l). Ammonia concentrations ranged from 0.57 -89.290 μg at-N /l with an annual mean of 9.952 μg at-N /l. Also, ammonia concentration recorded in 2003 was higher than the one recorded in 1999, which ranged from 0.14 to 19.39 μg at-N /l. Finally, the recorded values of Phosphate ranged between 0.22 – 1.64 μg at-P /l while the recorded values in 1999 was lower and ranged between 0.04 -1.21μg at-P /l.

b. Gulf of Aqaba

The sewage problem in Sharm El-Sheikh area is very limited or eventually controlled because of the Law 4/1994 where any direct discharge of untreated or treated sewage to the marine environment is prohibited. All hotels have to comply with these requirements and have acquired a sewage treatment system, or have been connected to the city sewer system. The treatment should be of tertiary or at least secondary treatment, where the remaining sludge is trucked away to the city municipal dumping area and the liquid effluents is treated. The bacterial counts for total coliforms recorded in Sharm El-Maya (in Sharm El-Sheikh) and the acceptable counts in the guidelines were 9–26 and 100 (cfu/100ml), respectively. The presence of faecal bacteria was attributed to the previous use of Sharm El-Maya as a berthing site for more than 200 motorized boats. These boats evacuate their waste in the water directly (none of the boats had holding tanks for their waste, and there was an absence of onshore waste receiving facilities). After 1999 the count of total coliform decreased as a result of moving the boats to the new jetty. A new port established in 1999 at El-Sharm Bay (TRAVCO Port) forced, by law, 300 diving boats anchoring there to carry septic tanks for wastewater, which are later pumped to the city sewer system by special receptors in the jetties. Only 80% of the boats, however, apply this system, while the remainder still discharge their wastewater directly into the Gulf of Aqaba without treatment, causing serious pollution and damage to the habitats of the bay and the adjacent reef.

During the rehabilitation of Sharm El-Maya project in 1999, the heavy metal concentrations in the bay sediments were measured. Generally, the measured metals (Copper,Cu,; Zinc, Zn; Cadmium, Cd; and Lead, Pb) showed significantly higher levels (7.3, 68.9, 3.5, and 20.8 ppm) i.e., 2 to 4 times higher compared to the control site concentration (4.8, 29.4, 1.2, and 5). Although, trace metals in the bay sediment showed clearly higher levels than the control site, most of the values were found to be within the range of the comparative survey made on sediment samples collected in 1983 and 1984. The range of the metals were 13-80, 15-100, 0.1-2 and 0.8-15 mg/kg-dry weight sediment for Cu, Zn, Cd, and Pb, respectively. On the other hand the metal concentrations in Sharm El-Maya water ranged between 0.08- 0.115, 0.131-0.509, 0.143-0.169, and 0.390-0.533 mg/l for Cu, Zn, Cd, and Pb, respectively.

In 1999 levels of Total Petroleum Hydrocarbons (TPH) were measured at Sharm El-Maya bay in sediments and water samples. The calculated mean of TPH in surface and deep water (close to the bottom) was 351.3 – 295.3 ppb, respectively; and 43.1 – 32.2 ppb at the control site. In the surface water of the bay, TPH concentrations ranged between 185.6 – 591.8 ppb. While in deep waters, the concentrations were 134.5 and 618.7ppb. The Total Petroleum Hydrocarbon content was analyzed in surface (0 – 20 cm) and deep sediments (20 – 40 cm). The highest concentrations were found to be in the surface sediments rather than the deep sediments at all the investigated sites including the control site. The minimum levels were recorded in the surface and deep sediments of the control site (14 and 6 ppm). The highest concentration was found in the inter-tidal sediments (1263.5 ppm) while the lowest concentration was recorded in the deep sub-tidal sediments (57.1ppm).

c. Other Red Sea Coast Areas

In other areas along the Red Sea coast, the primary source of elevated bacterial counts is the discharge of untreated sewage, whether from human settlements, tourist villages or directly from recreational boats. In general, dissolved oxygen levels were found to be within acceptable levels, with the notable exception of the coastal areas bordering major cities, ports and a number of tourist villages, where discharges of untreated sewage and industrial wastewater result in severe localized deterioration of the water quality. In these areas, dumping of solid wastes and litter into coastal waters is also a major environmental problem. The results of surveys showed that most of the litter originated from safari and diving boats. The different items collected were shredded car tires used as boat fenders, empty food and beverage cans, gas lighters, glass bottles, oil filters, and empty barrels.

3) Pollution Sources and Natural Pollution

a. The Gulf of Aqaba

The Gulf of Aqaba's environmental problems are primarily induced by tourism and associated activities as well as maritime traffic, which result in marine, aquifer, soil, and noise pollution, and destruction of coral reef and desert ecosystems. In addition, environmental issues, which are related to the management of wastewater and solid waste, are exacerbated by the increasing resident population of the coastal cities and the numbers of tourists visiting the area. Human impact on the environment can be summarized into seven broad categories, as follows: tourism, ship-based activities, wastewater management practices, solid waste management practices, ferry traffic, marine aquaculture, and cruise-boating. Environmental threats from natural causes are also of concern and can be categorized into floods and southern winds.

- **Tourism**

An estimated 500,000 tourists visited the Gulf of Aqaba coastal zone in 1996 and more than 3 million are expected in 2017. The relatively rapid growth of tourist visitation since the late 1980s has spurred interest in further development of tourism as an additional source of foreign income. The infrastructure needed to attend to the needs of tourism, i.e. shopping centers, hotels, airports, roads, dive boats, resort construction, all increase the environmental stressors on the coral reefs, but perhaps the greatest single threat from tourism is sheer ignorance. Dive clubs, which send divers into the reef without instructions or guidance, bear much of the blame for such actions, but even appropriate diver behavior is linked to reef degradation at high levels of activity. It has been estimated that sites hosting more than 6,000 dives per year degrade rapidly. Coral photographers, eager to get closest to the reef and distracted by their equipment.

- **Ship-based Activities**

Between 1985 and 1991, an average of 1,600 vessels handling 13 to 20 million tons of cargo each year, including oil, minerals and chemicals, entered the Gulf of Aqaba through the Strait of Tiran. The lack of a local capacity to contain and control any significant accidental spills of oil is a major concern. Other environmental issues relate to marine pollution resulting from frequent small spills of oil and other contaminants. In addition, waters are polluted by garbage and animal carcasses thrown overboard by ferries and ships. Reefs are also destroyed by ships that accidentally miss the navigational waterway through the Strait of Tiran.

However, on a day-to-day basis, small, recurrent leaks from cargo and pleasure ships, land-to-sea transfers, and the discharge of oily ballast water produce more pollution and do more environmental damage overall than one-time events like a large spill. Indeed, 97% of all oil spills into the sea are in amounts smaller than 4,000 liters. In the Gulf of Aqaba, such recurrent spills around the ports are already associated with the degraded health of local reef ecosystems.

- **Waste Water Management**

All urban areas are connected to biological oxidation sewage treatment systems. However, the population of Dahab and Nuweiba are not fully serviced due to insufficient infrastructure or lack of maintenance. This problem may affect up to 60% of the resident population. The remainder of the sewage is poorly treated before being released into the desert. Sewage treatment facilities in the Middle East region are poor in general, often amounting to little more than open settling pools. The impact of sewage on coral reefs can be unpredictable. Sewage creates localized areas of high nitrogen, which leads to algal blooms and deoxygenated "dead zones." In addition, sewage sediment settles on corals, particularly in regions without strong currents, choking the coral to death.

- **Solid Waste Management in Cities**

The cities in South Sinai, the port of Nuweiba, and the tourism resorts currently generate about 50 tons of solid waste per day. This has increased to 120 tons per day in 2002, and is expected to further increase to 220 tons in 2017. The municipal dumps are located unfenced and open to desert areas near the coastal desert road. Environmental concerns relate to the effectiveness of both the collection and disposal systems, which have resulted in the presence of unsightly refuse in urban areas to the town dump where open burning of rubbish also results in air pollution.

- **Ferry Traffic**

Oil transport into Nuweiba is minimal. A current problem is that of shipboard waste from the Gulf of Aqaba ferry between Nuweiba and Aqaba. Much of this waste is non-biodegradable and is carried ashore by currents, adding to the problems on the coral reef and Sinai coastline. In addition, similar problems arise from land-originated solid waste from the three bordering countries.

- **Marine Aquaculture**

  The rapid development of marine aquaculture in the Eilat region of Israel has already resulted in severe pollution of the marine waters surrounding the clusters of fish cages. This is raising concern of further eutrophication of marine waters in the Taba Area of Egypt.

- **Cruise-Boating**

  A visible marine pollution problem from maritime activities is the condition of the waters of the small harbor at Sharm El-Maya, in Sharm El-Sheikh. There is an accumulation of oil and sludge from the fleet of diving boats and other vessels that occupy the harbor. On-board sewage and solid waste are discharged indiscriminately into the harbor waters, with obvious and detrimental impacts on the nearby hotel beaches. The potential for increasing the number of boats using the harbor poses a major localized environmental threat.

- **Floods**

  Desert sheet floods sporadically supply large amounts of rainwater. Such floods have occurred in the 1950s and in 1979 and 1980.

- **Southern Winds**

  The common storms on the Gulf of Aqaba which are accompanied by winds of up to 23 to 41m/s knots provide considerable bursts of energy to water currents.

b. Gulf of Suez

- **Tourism**

  The negative impacts of coastal tourism are evident in Suez Canal's lakes and Ain Sukhna. These impacts include physical destruction of coastal habitats by construction works, dredging, and pollution from wastewater discharge from coastal resorts. The lack of proper land-use planning, including effective zoning and environmental review procedures in the coastal zone, particularly with regards to urban development and tourism expansion, is a growing problem in many parts of the region.

- **Ship-based Activities**

  One of the main sources of marine pollution in Suez Canal and Gulf of Suez is from ship-based sources. Transport of oil continues to play a critical role in marine pollution in the northern Gulf of Suez and Suez Canal. This transport traffic results in chronic marine pollution from discharges of oily ballast water and tank washings by vessels, operational spills from vessels loading or unloading at port, accidental spills from foundered vessels, and leaks from vessels in transit in Suez Bay. Other forms of ship-generated waste include oily sludge, bilge water, garbage and marine debris.

The Suez Harbour has always been an important Egyptian gate on the Red Sea since historical times. The growing activity of this harbour has led to an increasing rate of urbanization in the whole region. Taking advantage of the site location, several industries have been established all of them along the western coastal stretch of the Suez Bay in the south. The growing industrial activities coupled with the fact that Suez represents the southern entrance of the Suez Canal have resulted in the transformation of the whole Suez Bay into a large harbour. More than 100 ships and tankers are waiting daily to cross the canal to the Mediterranean.

- **Wastewater Management**

The first elements of a municipal wastewater collection and disposal system for Suez were installed during the mid 1920s. The system was expanded and modified during subsequent years, providing service to Port Tewfik area and to about 70 percent of the urbanized area of Suez at the time hostilities broke out in 1967. During that conflict, a considerable amount of damage was done to the system. Until August 1995, the treatment plant was primitive and of limited efficiency. It included primary treatment ponds of 5 acres. The wastewater was then discharged into the bay through El-Kabanon Drain, an open drain, 6 km south of Suez. The sewerage system was constructed to serve 98% of the domestic and commercial wastewater, while 2% were discharged directly to the sea. In 1999, the discharge amounted to 75,000m^3/day in winter, increasing to 85,000 m^3/day in summer.

A new wastewater treatment plant has been constructed, and is fully operational. It provides treatment capable of meeting the legal effluent standard for BOD (Biological Oxygen Demand) and TSS (Total Suspended Solids). The planned system of treatment includes 4 aerated oxidation ponds and 2 basins for mechanical separation of settled solids. The precipitated sludge is dredged every 6 –12 months (depending on the amount of solid material), transported to drying lagoons and then stockpiled for possible use for agriculture purposes. The plant is designed to treat 260,000 m3/day. However, the discharge of municipal wastewater at Lake Timsah and Suez Bay continues to present considerable management problems. In the region, especially on Lake Timsah and south of Suez, the discharge of domestic sewage contributes, through nutrient loading and high biological oxygen demand, to the eutrophication of coastal waters around selected population centers, major ports and tourist facilities.

- **Industrial Activities**

The development of Suez is seen as centering on a mix of labor and capital-intensive industries, developed on the existing base of petroleum and petrochemical plants. Industries in Suez City that are functional at present include a fiberglass boat building plant, machine shop and assembly plant, merchant steel mill, ship scrapping yard, general engineering foundry, ceramic tiles plant, and denim plant. Industrial effluents, in the form of thermal pollution from power and desalinization plants, hypersaline brine water from desalinization plants of Ain Sukhna hotels, particulate matter and mineral dust from fertilizer and cement factories, and chemicals and organic wastes from food processing factories at Suez City, contribute to the land-based sources of pollution affecting coastal waters in the Gulf of Suez and neighbouring water bodies.

From the fertilizer and chemical industry, El-Nasr Company produces 1,00 ton/day of ammonium nitrate, 500 ton/day of calcium nitrate and 50 ton/day of ammonium sulfate, besides, aqua-ammonia, sulfuric acid and nitric acid as byproducts. The company is located 2 km inland at about 8 km southwest of Suez City. The factory uses freshwater for cooling and the effluent discharge amounts to $60x10^3$ m^3/day of low saline water (2.5%). As expected, this water is loaded with ammonia, phosphate and nitrate in addition to certain metals e.g. Cu, Zn and Pb (Copper, Zinc and Lead, respectively). As for the cement industry, Suez Cement Factory lies 40 km south of Suez City. It was estimated that more than 10 g Pb and 600 mg Cd per ton of cement produced is released into the atmosphere. The cement factory lies on the coastal strip of the Gulf of Suez (5 km inland). Its location and the prevailing northwest winds heighten the amount of heavy metals and dust contributed by the factory to the marine ecosystem.

- **Dredging and Filling Operation**

Dredging operations of Suez Canal, and dredging and filling operations are a significant source of environmental degradation in the region. Sedimentation from these operations suffocates the surrounding benthic communities and has an adverse effect on other ecosystems to which currents transport the suspended sediment. The net results are the irreversible loss of the most productive coastal ecosystems – sea grass beds and dependent marine communities.

- **Offshore and Inshore Oil Production**

Extensive oil production operations are taking place in the Gulf of Suez, both inshore and offshore. The spills from oilrigs and ships have severely affected the inter-tidal zone in the central and southern parts of the Gulf of Suez. Many rocky shores are blanketed with oil pavements and oil is found buried beneath a thin veneer of wind blown sand in some beach areas. Not only are the direct effects of spills of importance, but also, of much concern are the drilling operations themselves. The discharge of drill mud and rock cuttings during operations results in high turbidity of water probably extending for a few kilometers in depth. The sediment loading from drilling operations has killed hermatypic corals.

There are two major refineries in Suez: El-Nasr Petroleum Co., and Suez Petroleum Co.

They are located in the Zeitia area about 3 – 5 km south of Suez City. Atmospheric pollution is mainly caused by sulfur oxides, hydrocarbons, nitrogen oxides, and carbon monoxide. The refineries in Suez have old burners and the combustion of released gases is not complete, therefore causing a high emission factor for gases. Emission of elements such as As, Cd, Co, V, Ni and Cu (Arsenic, Cadmium, Cobalt, Vanadium, Nickel, and Copper) are also included.

- **Power Generation**

The thermal power station at Ataqa (8 km South of Suez) is one of the largest in Egypt designed to generate 900 megawatt/hour of electric power. Cooling water is taken from the Suez Bay via an open canal extending over a half kilometer into the sea. The cooling effluent is about 200 m^3/hour, while the sewage discharge is 100 m^3/day.

- **Fishing**

Improper resource management, in conjunction with a lack of low enforcement, is a barrier to sustainable development of the marine resources in the Gulf of Suez. The status of fisheries is unknown because of a lack of stock assessment and incomplete and unreliable fisheries statistics. Interviews of fishermen reported declines in catches and average size of fish landed, which indicates over-fishing and stock depletion. The present situation is attributed to destructive fishing practices, possible exploitation beyond maximum sustainable yield, the absence of fisheries management plans, and a lack of surveillance and enforcement of existing regulations.