

# Environmental Crisis in the State of Kuwait: AS a Result of the Burning of the Oil Wells

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## 1- Introduction

Pollution, in a broad definition, is the contamination of any feature of the environment (air, water, soil etc.) making it offensive or harmful to human, animal or plant life. Emissions of substances into the atmosphere (through either anthropogenic or natural causes) may lead to air pollution where other factors lead to their concentration. The relationship between emissions and harmful effects is complex, however, with other factors influencing when, where and to what extent pollution occurs. Figure 1 simplifies the relationship between these factors.

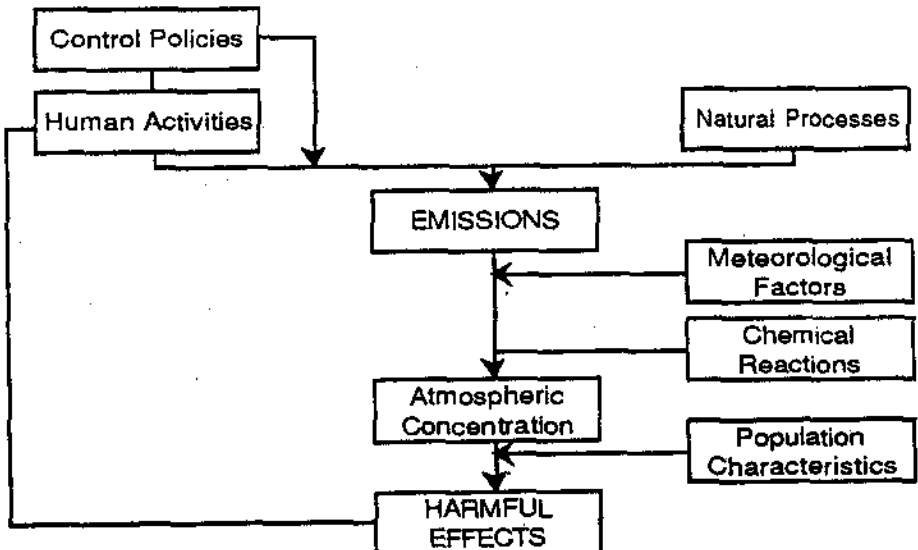


Fig 1 A simplified conceptual framework showing factors involved in pollution (J L Horowitz 1982)

## 2- Major Natural Components of the Atmosphere:

The major natural components of the atmosphere is shown in Table 1. It is the product of millions of years of evolution, both earth's surface structure and of the presence of life.

Table 1 Components of the Atmosphere.

Component	Percentage in Atmosphere
Nitrogen	78.08
Oxygen	20.95
Argon	0.93
Carbon Dioxide	0.03
Hydrogen	0.02
Neon	0.002
Helium	trace
Water	variable according to conditions
Inert Gases	trace
Ozone	trace but concentrated in ozone layer
SO <sub>2</sub> and H <sub>2</sub> S	)
Oxides of N <sub>2</sub> and NH <sub>3</sub>	) trace but localised at points where gases produced
Carbon Monoxide	)

(1) Meteorology of Air Pollution; Implications for the environment and its future; A S Scorer (1990) (NM: Ellis Horwood)

For the purposes of this study, pollution will be defined as components in the environment produced by man. They may not have an effect on the biosphere. It is useful to note here that some gases associated with pollution; oxides of nitrogen, sulphur dioxide, carbon monoxide, carbon dioxide; as well as smoke and dust, are added to the atmosphere quite naturally by volcanic activity, sub-aerial processes and biological activity. These can have a strong effect on local environmental conditions.

### 3 Sources of Pollution

Sources of emissions are classified as point, area or line dependent upon the magnitude and geographical distribution of emissions:

- i) **Point Source:** Large, geographically concentrated emitter, whose emissions are large enough to be significant on their own. E.g. A coal fired power station.
- ii) **Area Source:** Small, geographically dispersed emitters which are not significant individually but together make an environmental impact. E.g. The street system of a city.
- iii) **Line Source:** A collection of small, individual emitters distributed roughly linearly. E.g. A busy stretch of motorway.

Air pollutants are classified as Primary (ie. emitted directly into the atmosphere) or Secondary (ie. formed in the air by chemical reactions taking place after emission). These act alone or synergistically to increase natural stresses on ecosystems. As an overall group, air pollutants create an increased risk to human health, cultural or natural resources and atmospheric visibility with associated effects for agriculture. Risks to the structure of society through the pollution of the workplace, home and recreation environments and lifestyle have also been documented (e.g. Watson, Bates+ Kennedy 1988).

A range of problems associated with air pollution involve many of the same materials many, Emitted following the combustion of fossil fuels, are experienced on a local or global scale:

- 1) **Sulphur dioxide (SO<sub>2</sub>):** emitted during the combustion of sulphur containing fuels (coal and oil). In air SO<sub>2</sub>

reacts with water to form sulphuric acid and sulphate salts. Sulphur oxides are respiratory irritants and when mixed with particulates (e.g ash or soot) may form deadly smogs like the notorious 1952 London smog during which 4000 people died of bronchial and other respiratory complaints (K R Smith 1987). The effects of acid precipitation are also due largely to the emission of  $\text{SO}_2$  and will be discussed later in this paper.

- 2) **Carbon Monoxide ( $\text{CO}$ ):** This gas is emitted if inorganic fuels are incompletely combusted (in all internal combustion engines for example). It is extremely toxic but at urban air levels it is not fatal although it can aggravate cardiovascular diseases and cause problems with the nervous system.
- 3) **Nitrogen dioxide ( $\text{NO}_2$ ):**  $\text{NO}_2$  is brownish with a pungent odour and is the cause of the brown skies seen over many cities. Nitrogen oxide is formed during the combustion process in car engines and  $\text{NO}_2$  is a secondary pollutant formed in the air. It is a major urban pollutant combining with atmospheric  $\text{H}_2\text{O}$  to form Nitric acid, Nitrate salts and acid rain. As well as damaging buildings, it is a pulmonary irritant and is harmful to plants.
- 4) **Ozone ( $\text{O}_3$ ):** Another secondary pollutant, ozone is formed in the troposphere by photochemical reactions involving Hydrogen chloride ( $\text{HCl}$ ) and Nitrogen oxides ( $\text{NO}_x$ ). Ozone and the byproducts of photochemical reactions (e.g. Nitric acid,  $\text{NO}_2$ ) act synergistically as photochemical smog, an urban problem occurring diurnally.
- 5) **Heavy Metals:** Heavy metals have a density greater

than  $5\text{g}/\text{cm}^3$ . They are emitted during the combustion of waste, industrial processes and, in the case of lead, from petrol. Entering the atmosphere in a vapour state or as particulates in fly ash from incinerators, they can have serious implications for the health of people living within a range of a few km. Many heavy metals are toxins or carcinogens and can bioaccumulate in the body. Of particular concern are Arsenic, Cadmium, Lead, Mercury and Nickel.

- 6) **Hydrogen chloride, Hydrogen fluoride (HCl, HF):** During industrial processes and waste burning, the reaction of Chlorine and Fluorine with hydrogen ions from the combustion of Hydrocarbons forms HCl and HCl combines with  $\text{H}_2\text{O}$  to form the secondary pollutant Hydrochloric acid. In health terms this can irritate mucous membranes but is not fatal. HF may be a problem if high concentrations are inhaled long term but the average urban Fluorine intake is 1200 mg daily of which only 1% is through inhalation (DePaul+ Crowder 1989).
- 7) **Chlorofluorocarbons (CFCs):** Emitted from industrial and domestic processes and form the destruction of insulation, blown foam, refrigerants, solvents and aerosol propellants. They are chemically stable and do not cause problems on a local scale. In global terms, however, they are involved in the destruction of stratospheric ozone and the associated health implications in the Southern Hemisphere.
- 8) **Carbon dioxide and Methane:** Carbon dioxide is emitted during the aerobic combustion of fossil fuels. Methane is emitted during the anaerobic breakdown of carbon in farm animals digestive systems and

agricultural practices. Both of these gases are harmless to humans but contribute extensively to the greenhouse effect (Methane is a three times more effective greenhouse gas than Carbon dioxide).

#### **4 The Scale of Pollution problems**

The scale of the problem of air pollution is now global. Both in terms of local incidences of industrial and urban transport pollution occurring in most countries and in terms of long distance transportation of pollutants it is of great importance when considering the human impact on the environment:

- i) **Local scale:** This scale is used to describe pollutants which only travel a few kilometres, eg. Urban pollution.
- ii) **Regional Scale:** Regional scale transport occurs to distance less than 1000 km and also sub-continental and continental distances (several hundred to a few thousand km), eg. Acid precipitation.
- iii) **Global Scale:** Extends from 1000s km to the entire atmosphere. This is of concern when discussing the depletion of stratospheric ozone or global warming.

#### **5 The World Environment Catastrophe**

Nature can adapt most easily. However, nature has had a severe blow with regard to the marine, ground and air elements in the State of Kuwait. With these words, Dr Silvia Earl, chief Scientist at NOAA, described what happened to the Kuwait environment as a result of the burning of the oil wells.

"The world has never before witnessed an environmental pollution of the size of the pollution which resulted from the burning of the oil wells of Kuwait, where 732 out of 1080 wells

were put on fire. These wells centered in the Northern, Western and Southern areas of the country. Figure 2

The quantity of oil burnt out in these wells is estimated at approximately 6 million barrels per days. Part of quantity was burnt out and the other part what spilt as crude oil, thus forming oil lakes, now estimated at 200 lakes covering a large area with a depth ranging from 5 to 30 cm. The quantity of black smoke which has been emitted by the burning oil is estimated at 14-40 thousand tonnes per day. Sulphuric compounds emitted are estimated at 5-65 thousand tonnes per day in addition to 500-600 tonnes of nitrogen oxides per day.<sup>9</sup> (KISR, 1992).

Ecologists agree that this catastrophe is not limited to Kuwait or the Gulf region only, but extends to other regions and countries which are very remote. The latest scientific reports on this matter indicate that clouds of dense black smoke resulting from the burning oil wells of Kuwait are not close to the Greek coast after they have crossed the Black sea. These clouds, therefore, are threatening several countries in that part of the world, such as Rumania and Bulgaria.

As we know, the pollution problem is a global one that does not stop at political or regional boundaries. The whole world is one single and integral ecological unit, and the Arabian Gulf is part of the ecological system of the Earth, and regional environmental effect will certainly, with the passage of time, have an impact on the planet's environment. At first such impact may be invisible because of climatic conditions which vary from place to place and particularly the winds which can carry vaious kinds of pollutants over long distances, so that it becomes most difficult for man to determine its route with a reliable degree of accuracy. The

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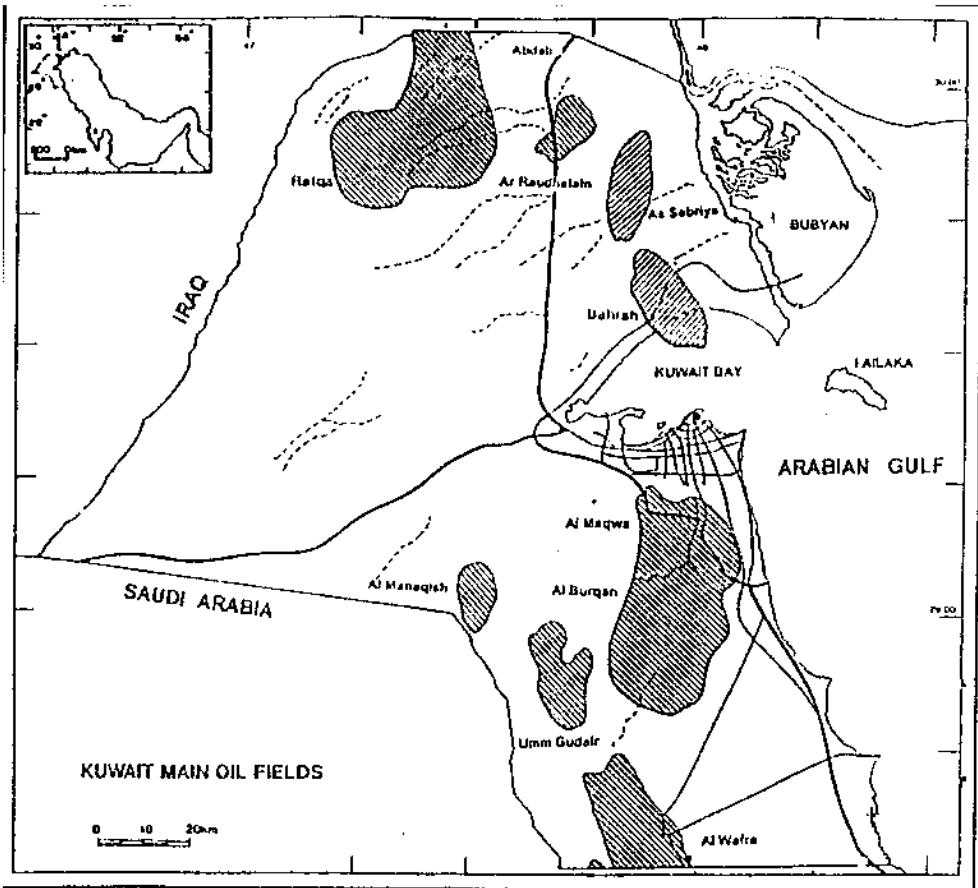


Fig (2) Burning Oil Wells in Kuwait



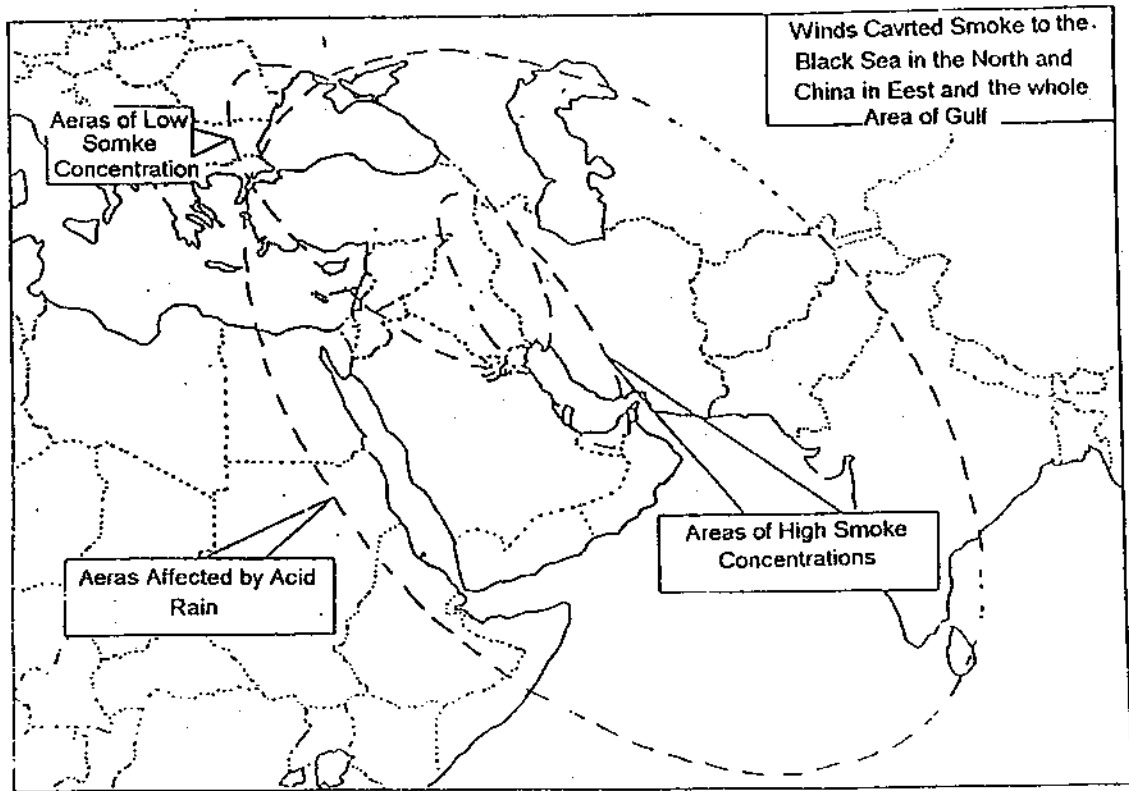


Fig (3) Area Affected by Burning of Oil Wells in Kuwait.

situation is further complicated by the fact that wind direction change from one day to another, and this renders even more difficult the job of determining or containing these pollutants.

It can therefore be said that the pollution resulting from the burning of the Kuwaiti wells is not a problem that concerns Kuwait alone, or even the Gulf Region only, but that this is a world problem that should be dealt with at the international level, with all the capabilities available to mankind.

The established fact now is that Kuwait is currently facing a most serious environment: catastrophe, for the atmospheric temperatures are below their normal levels., because the rays of the sunlight have not been allowed to reach the earth. This is in addition to the black rain or environmental winter phenomenon. Which can destroy living creatures and plants and cause a serious inequilibrium in the basic elements of soil.

## **6- Environmental Damages to the Climate**

The crime of setting fire to more than 732 oil wells has brought about one of the greatest environmental catastrophes ever faced by man. It caused the emission of thousands of polluting gases every day. Over a period of eight months. These pollutants will accumulate in the lower part of the atmosphere, where a higher concentration of carbon dioxide is forming. There is not chance that these gases will be washer away by rain fall. In normal circumstances rain cleans the air from carbon dioxide suspended in the air. However, in This situation, rain will fall and it will be carrying large portions of serous and dangerous compounds. The clouds will, therefore, be polluted and will be spread over large areas of the globe as a result of the air

currents, such as the north-westerly winds which blow normally from the tropical regions of the Arabian Peninsula, Egypt and North Africa. The polluted clouds will cause a radical change in the distribution of the atmospheric pressure areas, thus causing changes in the seasons of the year in a most remarkable manner. Figure<sup>3</sup>.

**Several scientific reports issued by the American Environment Protection Agency indicate that the soot levels recorded over the Hon Lawa observatory in Hawaii In March 1991 were five times as high as their levels during the same month in each of the previous three years.**

Other scientific reports issued by Young University state that the soot emnatin from Kuwait has reached the USA: The particle concentration levels in the lower part of the atmosphere in the region around the University has risen by one tenth during the months of February and March. Smoke emitted in Kuwait may cover the entire US East Coast from New York City to Florida. Traces of soot have been detected in Japan, and black smoke has been seen in palces 2000 km far from Kuwait, in India, China and several areas in the Soviet Union where the fall of acid rain has reached record levels.

Smoke emitted in Kuwait is regarded as one of the factors that assisted in the occurrance of floods and hurricanes causing the death of more than 100.000 people in Bangladewsh on May 1, 1991, when water levels rose by two feet above their previous normal levels and rainfall was unusually heavy. Of course, a more detailed and lengthy study needs to be undertaken to determine the relationship between those hurricanes and the black smoke emitted in the State of Kuwait. However, the theory of linking the hurricanes

that took place in several countries of the world to the burning of the Kuwait oil wells rests on the reasoning that the burning of the wells causes the temperature of the air and ground to rise and the fall of the monsoon rains to increase thus causing a rise in the levels of rains and water in lakes in various parts of the world.

Richard Cowtson of the Maxby Blank Institute in the USA says that if 1% of the smoke reaches the stratosphere, temperature in the Northern Hemisphere of the earth will drop by two degrees centigrade, and such drop will cause serious and extensive climatic changes.

Several studies have predicted a fall of some 10 degrees centigrade in an area within a radius of hundred of kilometers around Kuwait, and a fall of one or two degrees centigrades in an area within a radius of one thousand kilometers around Kuwait. Events during the recent past tend to support these predictions, for several gulf countries have witnessed the coldest weather experienced over the past 35 years.

The increase in pollutant concentrations in the atmosphere will cause a part of the sunshine to be reflected back and another part to be absorbed. This will affect the layers of the atmosphere close to the surface on the earth. This has been experienced clearly in the obvious fall in the temperatures in certain parts of the State of Kuwait. The emissions of carbon dioxide and other gases also compounds the glass house problem, for the group of pollutants from a thermal blanket which checks and absorbs a part of the sunshine and reflects the rays of sunlight, thus causing the earth temperature to rise.

Furthermore, winds and sandstorms may have a huge

impact on increasing the hazard of polluting the environment. During the sand storm season from May onwards, the wind carries dust and sand as well as gases to the various areas in the Arabian Gulf region. Needless to say, the trenches, sand barriers, excavations and the heavy movement of vehicles over the sands in the area have provided the raw materials for creating the winds and caused sand storms to erupt in a denser manner, which will be mixed with the mist cause by oil and the soot resulting form the burning wells.

As a result of the burning of oil and the rise in the percentage of certain types of pollutants in Kuwait, such as sulphur dioxide, which is an active element in most pollution matters, and which is therefore a source of danger, one needs to find out the concentration levels of pollutants of the atmosphere. To do that, we need to look at some of the recordings made in the observation stations at Mansouriah and Rigga area. We shall later on try to determine the nature of the relationship between the average pollutant concentration of the one side and the wind direction on the other side, for the months of May October 1991.

Nitrogen oxides have reached their highest level, having reached 424.0 and 1187.0 parts in a million at the Mansouriah and Rigga stations respectively in May 1991. With regard to the month of October in the same year, nitrogen oxides reached 1709.0 and 558.0 parts in a million, whilst the ozone registered its lowest reading, i.e. a concentration of 0.043 and 0.06 parts in a million in the Mansouriah and Rigga areas respectively during October 1991.

If we consider the concentration of sulphur compounds at the Rigga and Mansouriah stations in the light of changes in the wind direction, we find that these pollutnats are clearly affected by the wind. IN the Mansouiah area the wind is South

Westerly and in the Rigga area, the wind is Northerly, during the month of May 1991.

With regard to the concentration of sulphur dioxide gas, the highest level of 3.268 parts in a million was recorded when the prevailing winds were southerly. At Rigga the highest concentration was 4.252 parts in a million when the prevailing winds were northerly during the same month. (Ministry of Health 1992)

During October, readings indicated that the sulphates group recorded its highest level when the prevailing winds were south westerly. The level reached was 6.337 parts in a billion. The lowest part recorded, when the wind turned south easterly was 2.163 parts in a billion.

with regard to sulphur dioxide gas, it reached its highest levels when the prevailing winds were north westerly at the Mansouriah station. At the Rigga station, the highest concentration of sulphates group was recorded at 12.445 parts in the billion when the southern wind was prevailing, whereas the lowest level of 2.155 parts in a billion was recorded when the prevailing winds were north easterly. Sulphur dioxide gas reached its highest levels of concentration when the prevailing winds were southerly, reaching a level of 11.173 parts in the billion in October. (KISR, 1992)

## **7 Environmental Damages to the Soil**

The large oil fields cover large areas of land in the North and South of the country. Total area affected is 50 square kilometers, with a depth ranging between 5 and 30 cm. These *oil lakes have caused the pollution of the soil with petroleum materials.*

Crops and Wildlife, as well as natural pastures have

suffered and animals have been poisoned by the increase of hydrocarbon materials concentration.

In view of the fact that the existence of the oil lakes has a most serious effect on the soil in the State of Kuwait where soil is mainly sand with a 90% content of clay and mud, which is considered a poor formation, as this soil is poor in organic materials and water keeping capability is weak.

Oil has seaped into ground and pools and even lakes of mud and residues have formed around the oil wells and these are surrounded by sand dunes. The spilt oil has mixed with the soil water, sand and salt crystals to form a mixture which consists of 50% of oil, 45% of water and 5% of sand.

Needless to say, the sand lakes have a negative impact on the Kuwait soil, so that restoring the fragile desert environment to its previous normal condition will now take many years.

However, we should keep in mind the fact that the calculation of the actual damage suffered by the soil in the State of Kuwait is still in its early stages. There are, of course, certain deficiency in several areas of dealing with this matter, and these should be overcome quickly so that a proper appraisal of the environmental effects on the Kuwait soil may be made. In any event, the degree of pollution of the soil by the various pollutant depends on several factors which are interacting and inter-dependent. The properties of the pollutants and the soil constituents also play a part in determining the extent of the soil pollution. For this reason it is most important that the properties of the pollutants and the formation of the soil be studied most carefully in order to determine the extent of such pollution.

There are several methods which can be used to clean

the soil from hydrocarbon pollutants resulting from the oil lakes. The major methods used are the following:

- 1- To move the polluted soil and dump it in special waste dumping areas after ascertaining that it does not contain any hazardous pollutants.
- 2- Mix the soil with fertilisers to give the chance to the bacteria to break down the polluting materials.
- 3- Use special solvents which can separate the pollutants from the soil. The pollutants can then be removed by the use of special equipment.
- 4- Suction of the oil from the lakes to special tanks after they have been purified.

Nature also plays a part in dealing with the soil pollution with hydrocarbons resulting from oil lakes. This is achieved by the fact that the soil contains certain types of bacteria which break down the petroleum derivatives by feeding on them. Furthermore, the movement of sand and dust falling on the lakes helps in making the pollutants disappear with the passage of time, for the clean soil mixes with the polluted soil and causes the pollutants to disappear gradually.

## **8 Environmental Damages to the Water**

Scientific studies have shown that approximately 6000 barrels of oil leak every day into the waters of the Arabian Gulf and that there are approximately 128 oil slicks opposite the coasts of Kuwait and Saudi Arabia. A study conducted by ARAMCO indicates that most bays in the Arabian Gulf have suffered pollution in one way or another. The spring waves has caused the oil slicks to return to the bays which had been cleaned. The pollution concentrates opposite the coasts of Kuwait and Saudi Arabia, from Al-Safaniah to Abu Ali where oil flowed at the rate of 3000 to 6000 barrels per



day from eight sources.

The pollution which affected the waters of the Arabian Gulf waters did not affect only the water desalination operations but has had a very serious effect on the marine living organisms and the food chain. Living organisms have abandoned this area, and the remaining organisms have died. This is due to the fact that the oil slicks do not allow the oxygen and sunlight to reach the bottom of the sea. The coral reefs have been destroyed, after having served as a home for marine organisms and sea animals. Many years will pass before the marine environment can be restored to its former balanced condition.

the flow of oil from the destroyed wells has also polluted ground water for large quantities of oil have seaped and created large oil lakes which have started to threaten the sources of ground water for irrigation. The effect of the oil leakage has been quite evident with regard to the ground water of the Kuwait Group. It is a known fact that the Kuwait formations are located in the North of the country, particularly in the Rawdatain and Umm Al-Aish areas. These consist of land and gravel residues which are highly permeative. Therefore, oil may easily leak to the ground water in these areas through rainfall, for the oil lakes form in the valleys and low areas. When rain falls onto these areas it tends to seep down to the ground water.

With regard to the Dammam formations, which are located in the Southern Region of the country, where clay formations are prevalent. This area has many cracks through which oil can leak down to the ground water. In these formations, the ground water is close to the ground level and this makes the risk of pollution even higher.

## **9 Economic Damages to Oil and Industrial Installations**

It would be appropriate, in this context, to discuss briefly the conditions of the oil sector and the performance of the Kuwaiti economy during the period prior to the Iraqi invasion, in order to illustrate the immensity of the economic losses and damages caused by the Iraqi invasion of the State of Kuwait.

The Government had given special attention to the development of the industrial Sector on sound and well-considered scientific bases, in the light of economic and social plans. Crude oil production was fixed in the mid-seventies so that it would not exceed 2 million barrels per day.

This ceiling was adhered to until the mid-1980's with the exception of 1979 when the total production averaged 2.2 million barrels per day, as a result of certain international political and economic developments forced the producing countries to increase their production levels.

During the period from 1985 to 1989, the maximum oil productions was 1.5 million barrels per day.

During 1989, oil prices improved remarkably, having achieved an average rise of 20.7% for the Kuwaiti oil, to reach US\$ 16.3/barrel. Although this average rose to 18.1 dollars during the first quarter, it fell off to 14.8 dollars in the second quarter, then rose to 16.1 dollars in July 1990.

In the light of the production and export averages and average oil prices, as well as the improvement in the exchange rate of the US dollar, the State of Kuwait achieved a 60.7% increase in its oil revenues, to reach KD 3.026 million in 1986, with an increase of KD 1.143 million over 1988.

During the first quarter of 1990, Kuwaiti exports registered a remarkable increase, reaching KD 816.1 million compared with KD 554.9 million and KD 482.7 million during the first quarter of 1988 and of 1989, respectively.

If we add the exports of the first quarter to those of the second quarter of 1990 (KD 670.2 million), the total exports of Kuwaiti oil during the first seven months of 1990 amounted to KD 1732.6 million.

The industrial sectors associated with the oil sector with the oil sector witnessed an impressive expansion. The Mina Abdullah Refinery was renovated and upgraded to a production capacity of 200,000 barrels per day (from 75,000 barrels per day). This brought the total refining capacity of the three refineries to 750,000 barrels per day. There has also been a remarkable work concluded with many companies in various parts of the world for the marketing of the Kuwaiti oil products. The distribution stations of the Kuwait National Petroleum Company rose, and the production capacity of the refining and distribution stations in Western and Eastern Europe increased to 23,000 barrels per day in Eastern Europe.<sup>(1)</sup>

This shows that the oil sector, prior to the Iraqi invasion, achieved an impressive improvement in production, refining and export operations. This, in turn, had a positive effect on the Kuwaiti economy which achieved considerable growth during the 1980's and early 1990's.

Then came the Iraqi invasion to impair the progress of the country's economic development.

Since the source of the economic progress is the oil

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(1) Report submitted by the Central Bank of Kuwait concerning the situation in the oil sector, 1991 P.P 2-5

sector, the enemy committed and almost complete destruction of this sector. Most of the oil wells were either destroyed or blown up. The fate of the collection centers and export facilities was not better. This is in addition to the negative environmental and economic effects arising from the burning of the oil wells and wasting the main natural resource of the State of Kuwait, and causing an environmental catastrophe of a scale which the world has never witnessed before.

## **10 Conclusion**

To illustrate the economic and environmental losses caused by the Iraqi aggression, the damages may be summarised as follows:

- 1- Destruction and setting fire to 732 out of a total of 1080 oil wells. A total of 6 million barrels of oil and 70 million cubic meters of natural gas was wasted every day.
- 2- The main export port and the Sea Island (Artificial Island) were totally destroyed.
- 3- Total destruction of 25 collection centers.
- 4- The total value of wasted oil and natural gas from the burning or destroyed wells is estimated at US\$ 120 million per day.
- 5- Costs of the discontinuation of the oil production operations, estimated at US\$ 14.2 billion for the period from 2 August 1990 to the beginning of 1992.(1)
- 6- Reports of the Ministry of Finance state that the costs of reconstructing and restoring the oil sector may reach US\$ 80 billion. This figure includes the cost of putting off the oil well fires which have cost US\$ 1.5 billion approximately, the costs of repairing and recommissioning of the damaged or destroyed wells, the

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(1) Report submitted by the Central Bank - ibid 1991 .

drilling of new wells, repairing the collection centers crude exporting ports and piers.

- 7- Damages suffered by the established oil reserves of the State of Kuwait: This asset is invaluable because it is the reserve for the welfare of future generations of Kuwaitis and cannot be compensated for in any way whatsoever.
- 8- The material damages arising from the catastrophe can be compensated. However, the most important matter is the extent of the effect of this catastrophe on the Kuwaiti Society, the damages suffered by the Kuwaiti individual, the negative impact on the world ecology system which will need many years before it gets back to its normal condition and achieves a natural equilibrium.

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