IMPACT OF WAR ON ENVIRONMENT: THE CASE OF KUWAIT IN THE GULF WAR 1991

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ASHIHRU DIKHO

Centre for West Asia and African Studies
School of International Studies
Jawaharlal Nehru University
New Delhi-110067
India
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CENTRE FOR WEST ASIAN AND AFRICAN STUDIES
SCHOOL OF INTERNATIONAL STUDIES
JAWAHARLAL NEHRU UNIVERSITY
NEW DELHI - 110 067, INDIA

Phone Off. : 26704372
Telegram : JAYENU
Fax : 91-11-26165886
91-11-26162292

Date: 19 July 2004

CERTIFICATE

This is to certify that the dissertation titled "**Impact OF WAR ON ENVIRONMENT: THE CASE OF KUWAIT IN THE GULF WAR 1991**" submitted by **ASHIHRU DIKHO** in partial fulfillment for the award of the degree of **Master of Philosophy** has to the best of my knowledge not been previously submitted for any degree of this or any other University. This is his own work.

We recommend that the dissertation may be placed before the examiners for evaluation.

Prof. Gulshan Dietl
(Supervisor)

Dr. A.K. Pasha
(Chairperson)

Chairman
Centre for West Asian and African Studies
SIS, JNU, New Delhi-110067

Dedicated to

My Dearest Parents and Loved ones

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INTRODUCTION

Military operations often cause considerable damage to the natural environment. Manipulation of the environment itself may be used as a means of inflicting damage upon or impending the activities of the opponents. As an example of the latter, in the Gulf War 1991, Iraq's used Kuwait oil burning as an instrument to coerce the world powers to accept their term on the question of Kuwait. This had particularly pernicious effects on Kuwait and Persian Gulf eco-system never known before.

The Gulf war 1991 was not a minor incident in the history of conflict between Nations. However, it stands as a major, historic point in the changing nature of war and it raised the specter of large-scale environmental devastation; not only as a casualty, but also a strategy of warfare. The governments began to accept the irrelevance of national borders in environmental disaster like the Gulf-War on global environment. They felt the need to have a global environmental policy or modification of existing law by amending the existing irrelevancies, in order to prevent any large-scale environmental catastrophe in future conflict. This kind of wanton destruction killed not only the combatant but also savaged the lives of the innocent and affected environment beyond geographical boundaries.

After 45 days of aerial bombardment and intense eight days ground war, Iraq signed a cease-fire. This brought the Gulf War 1991 to an end. But the war continued for Kuwaitis. As the war continued, so did

the suffering of the civilians. They were deprived of all the basic health facilities, at the time when they needed them the most. The problem was further compounded when all the expatriate health workers, who constituted about 80 to 90 per cent in the health sector, fled the country. This brought the country's health care to a stand still.

Environmental fallout from sabotaging oil wells affects not only human beings alone, but also the marine and desert ecosystem as well. They were put under various degrees of stresses, never known before. Smoke from oil fires cast a dark shadow over the northern Gulf, dramatically reducing daytime temperature affecting both the sea grasses and plants from preparing their food in the sunlight. Spreading black rain like 'hell blest tears' to the distant heights of the Himalayas and the wheat field of Pakistan .The desert surface was oiled and bulldozed apart from planted with land mines. Delicate desert plants recently germinated were silent victims in natural environmental disaster of hell on earth.

The Gulf war 1991 was arguably the most ecological devastating military conflict in history. Yet, the enormity of the ecological damage cannot be examined or known with certainty because the "White house" censored all information related to public health and Environment. Simple reason was the government did not want to hear any bad news about possible environmental effects of the Gulf war. However, the Gulf War 1991 vividly demonstrated the awesome ability and readiness to attack

both our own spices and the wide range of tide-forms with which we share this planet.

It was also not justified, when allied military spokesman placed virtually all the blame on Iraq for environmental damage. Of course, Iraq played by far the major role in creating the ecological nightmare, and one could legitimately argued that it carried an indirect responsibility for the entire consequence of the war. It cannot deny the fact of the coalition forces responsibilities on environmental damage.

The real peace in the Persian Gulf or in the West Asia is still a long way off. Weapon still pour into countries around the Gulf state. For instances like Iran nuclear Technology question, Saudi Arabian purchasing billion dollars worth of U.S jets, tanks and other Equipment, question of terrorism and stability in the region, the current United States Iraq occupation fiasco caused concern not only to the region alone but also to the world communities. It also indicates how the future would unfold in the region.

However, our effort to achieve peace to the conflict by peaceful means is motivated by a concern for human being. This sense of humanity should be guiding us to protect the foundation of human life – the natural environment. It is essential to implement effective multilateral mechanism to prevent the use of environment as a tool or weapons of war. As it is known that war cannot be abolish from the face of the earth. What

is needed is to restore or respect International laws relating to environment in times of war so as to avoid another ecological catastrophe.

The purpose of impact studies of war on environment (Gulf War 1991) is to reveal the consequences of man's action on nature; in return how nature produced a double impact, which has a chain of reaction, affecting all living creatures within the environment. The issues would raise and contribute to a better understanding of the importance of environmental protection in the context of international conflict and will inspire much needed action.

CHAPTER - I

ENVIRONMENTAL CONSEQUENCES AND HUMAN HEALTH

INTRODUCTION

A massive reconstruction programme followed after the liberation of Kuwait in 1991. Accordingly it was planned that the year 1992 should be the year of the new environmental perspective, where human being are to be considered as the most important target for any pollutant introduced to the environment.[1] It obviously affected human beings in so many varied forms. But the degrees and ways could never be known with certainty.[2] Nevertheless, those pictures from Vietnam War are to the reality of the gulf war than the ones presented on the nightly news. Vietnam children running naked down the road, crying from the pain of napalm searing their skin.[3] In Kuwait and Iraq during the Persian Gulf War 1991, it was not the napalm, but the Shrapnel, malnutrition, waterborne diseases that killed thousands of children. These indicate the fact that war harmed environment and killed or wounded non-combatants also.

Modern technology has greatly increased the scope of violence. The targeting of industrial facilities like oil fields, refineries and nuclear reactors, like setting 732 oil wells on fire and spilling 6-8 million barrels of oil has

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1 Farouk El-Baz and R.M. Makharita, *The Gulf War and the Environment* (Switzerland: World Trade Centre, Gordon and Science, 1994) p.1.

2 Thomas Cambay, "After the Storm", *National Geographic* (Washington D.C. 1991) Vol. 18, p.12

3 Saul Bloom (ed.) *Hidden Casualties: The Environmental, Health and Political Consequences of the Persian Gulf War* (London: Earthscan, 1994) p. xvi.

caused severe damage to the environment. Though, the effects of the oil well fires and oil spills on the gulf eco system and on human health are mostly unknown, both because of the very large number of variables to be taken into consideration and because of significant gaps in the available biological database.[4] Yet, it is believed to have immensely affected both environment and human health.

Identification of Problem: Steps Adopted to Combat Possible Health Effect.

The initial fear and many dire predictions were made at that time about the potential environmental effect from the burning of oil wells.

1. Health effects on local populations and animals, both the emission and Subsequent inhalation of toxic gases, together with the respiratory threat from high concentrations of sub micro-sized particles, especially carbon particles resulting from incomplete combustion (which might have toxic metal species bonded to their surface) and also salt particles form the brinc in the oil fields.

2. Potential ground-water contamination from the huge oil lakes around some of the oil wells.

3 The deposition on land and sea of large soot particles and unburned oil droplets, coating and possibly killing food-chain elements and also

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4 H. Bruno Schiefer (ed.) *Verifying Obligation respecting Arms Control and the Development: A Post Gulf War Assessment* (Canada: University of Saskatchewan, 1992) p.36.

possibly, depositing toxic amounts of metal species, particularly those containing nickel and vanadium.

The public health service (PHS) of the US Department of health and Human Services issued a plan of action for protecting public health in May 1991; it identified priority health issues related to the oil pools and oil well fires.

- acute or chronic hazard;
- exposure from the oil pools and oil well fires;
- nature extent of exposure
- public health infrastructure to be developed to identify and evaluate
- Possible adverse public health effects.
- risk management and disease prevention for those exposure; and
- new knowledge about the possible adverse health effects associated with
- Exposure.

It was also stated that hospital admission could be another's indication and how a population is dealing with a health threat, and that long-term health effects were not readily predictable because little is known about the consequences of such intermittent kind of exposure.

Public Health Service (PHS) also issued a health advisory (March 21, 1991) recommending four precautions and five actions in light of the health threat posed by the fires, the precautions were the following:

- Use protective clothing and medical evaluations for personnel stationed or working near the oil fields.

- Advice residents of methods to reduce exposure, and early warning signs and symptoms of exposure.
- Advice medical personnel of potential health hazards, and
- Evaluate the public health infrastructure.

Key actions recommended by public health service were:

- Developing a preliminary assessment of the areas through site visits by experts;
- Evaluating medical facilities for diagnostic and treatment capabilities
- Monitoring of air in all residential areas of Kuwait and Saudi Arabia.
- Exploring the feasibility of establishing a surveillance system for adverse health effect and
- Assessing resources and facilities to provide health alerts and information's to local residents.

It remains to be seen what has been learned from these precautionary statement and action plan.[5]

First Blow to Health Care

Before August 1990 Kuwait had achieved one of the highest health's standards in the world. It had a death rate of 2.4 per 1000 and infant mortality rate of 16.3 per 1000 live births and life expectancy at birth of 71.2 years and 75.5 years for male and female respectively. Communicable diseases and other

[5] Ibid, pp.141-142.

main contributors to childhood morbidity and mortality were brought under control. The national health services had gradually expanded their scope by directing diagnostic and treatment facilities for non-communicable disease, which required a constantly increasing level of technical sophistication and resources. This was reflected in number and quality of health facilities, the efficiency of the emergency medical care and creation of centres specialized in such areas as oncology, nephrology, organ transplant, open-heart surgery and neonatology.[6]

Kuwait before the war had six regional and nine specialized hospitals, 74 polyclinic and several medico-social institutions, which provided medical, surgical and dental care and rehabilitation extensive network. Nearly 10,000 nurses (of whom 90 percent were foreign workers) and more than 3,200 physicians (of whom 80 percent were foreign workers) provided the services with a ratio of physicians and nurses to population which compared favorably with most industrial countries in the world.[7]

When Iraq invaded Kuwait in 1990, all the facilities, which the Kuwaitis enjoyed, became a history. Thousands of people got severe and minor injuries. What was the need of the hour were hospitals, medical doctors, nurses and basic medical accessories to attend the people suffering. But the irony that aroused from the scourge of invasion was that the whole medical and health

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6 *Kuwait: Report to the Secretary General on the scope and nature of Damage inflicted on Kuwait infrastructure during the Iraq occupation* (Nairobi: United Nation Department of Public information, 1991) p.69.

7 Ibid.

care system collapsed and life style came to a standstill. Worst of all, the expatriate health workers fled the country. Within three months nearly 80 percent nurses, two-third of the physicians left the country and others were taken to Iraq under an exchange programme that would provide for their replacement. And others did not turn up for work. This was the first blow to the Kuwaiti public health system since the invasion started.

The depletion of personnel can be illustrated by the example of the Al-Amiri hospital, which saw its number of physicians reduced from pre-invasion level of 160 (including 60 surgeons) to 8 (including 5 surgeons). Meanwhile, the number of nurses fell from 540 to 60 and this compelled the hospital to close down 10 out of its 12 wards. The Muburak Alkabar hospital lost 60 percent of its medical and nursing staffs. The Jahara hospital with a capacity of 500 beds had to be closed as its number of physicians fell from 300 to 45, nurses from 400 to 30 and laboratory and other technicians from 120 to 25.[8]

The destruction and removal of modern equipment from the hospital further aggravated the situation. This was particularly visible in the electro medical field. Large amount of equipment were taken way by the occupying force. Not only that, major damage was done to the laboratory with some of the heavier equipment was dismantled and the ultrasound rooms were emptied of

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[8] Ibid., p.70.

their apparatuses. All the equipment from the public health viral laboratory removed. The surveillance system had also come to stand still.[9]

Important health department like the Kuwait Cancer Control Centre was a diagnostic treatment and research centre that provide services to person from other countries in the region ceased operation shortly after occupation, while no damage was caused to the structure of the Al-Razi orthopedic center, it was left with only few qualified orthopedist. The number of physician and nurses fell from 80 to 20 and 200 to 50 and the number of support staff from 200 to 70. As a result the center could perform only three operations a day as against 10 earlier. All the ambulances had been removed from this hospital. But the most acute problem face by the hospital were the shortage of staff and on the above the lack of electricity and the water supply.[10]

The centre for organ transplant laboured a dialysis center and surgical unit in a modern building situated within the Al-Sabah complex. Here too, besides, damaging the building most of the equipment was removed, including the dialysis machines, electro medical apparatus and much of the furniture and equipment from the operating and intensive care rooms. Floors had been littered with patient's files, registers and small equipment. Maternity hospital was not better. Factors ranging from scarcity of personnel and removal of

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[9] For details see Gaafar Karrar and others, "A Rapid Assessment of the Impact of the Iraq-Kuwait Inflicted on Terrestrial Ecosystem" A Report prepared for the UNEP, 1991, *http\\unep.org.bh\regional. UNEP Kuwait*, Date 12/3/004. p.56

[10] Kuwait, n.6, pp.70-71.

incubators were the matter in this department. On the other hand shells damaged the institute of Islamic medicine. The institute had been emptied of its contents, which included a library, benches for laboratory work and furniture. The hospital and its store were vandalized and medical as well as other equipment, including telegraph and the telephone switchboard were removed.

Besides removal and destruction of a large number of equipment and supplies particularly, in sophisticated hospital Al-Amiri four-storey building was also damaged. At the same time "Ministry of Public Health" was transformed into a fortress with a large stock of ammunition. Computer equipment to process was deprived of reliable source of information, as there were no data flowing through the channel. The system to detect the possible reappearance of malaria or other vector-borne diseases or the occurrence of air and water pollution related illness was out of functioned. There was lack of water and electricity in hospital, spread of epidemic diseases, especially intestinal diseases due to the lack of hygienic drinking water due to the destruction of chlorine plant. "The inadequacy of sanitary facilities and shortage of medical service and medicine deprived the nation form full benefit of healthy human resources".[11]

Effects of Human Health from Burning Oil smoke.

The environmental damage affected almost all the environmental compartment in Kuwait and the surrounding areas; however, the air was

[11] Kaarar and others, n.9, p.56.

obviously and significantly polluted. Among all the environmental impacts that are likely to happen from massive released of heavy black smoke and gases was on human health's, especially when human being inhales daily about 15 kg of air as compared with 2 kg of water and 700 gram of solid food.[12] The smoke from burning oil wells affects the local population considerably.[13] It was not exceptional to those who entered Kuwait after the liberation of Kuwait as well. They often complained, the air is frequently painful to breathe and everyone feared these consequences to their health. The smoke covered the whole sky that even in daytime; it was so dark, photocells controlled lights had to be automatically switched on.

Different predictions about the fatality that would arise from the burning of oil wells were made especially about human health. Though, the exact nature of air pollution from burning of oil wells was not known with certainty, it was not men alone that were the victims. Animals' plants and all biological surrounding were equal victims. Yet, what was apparent was human suffering been so severe it was said that, "it was difficult and at time almost embarrassing, to be actively engaged in rescuing animals".

The major hazard associated with the smoke from burning of oil – wells were the particulate matter. Benzene, ethylbenzene, tolune and xylene and others were among the Volatile Organic Compound (VOC's) detected,

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12 Kuwait , n.6, p. 99.

13 Michael McKinnon and Peter Vine, *Tides of war. Eco-disaster in the Gulf* (London: Immel, 1991) p.153.

naphthalene's were among the PAH's detected. American inter-agency also finds out chemical such as sulfur dioxide, hydrogen sulfide, carbon monoxide and polycyclic aromatic hydrocarbon along with particulate matters and emission from oil well-fires". They stated that these had the potential chemical that would cause health problem both acute and chronic nature, although there was a considerable uncertainty as to the extent of threat.

United Kingdom Meteorological Report said effects from smoke and pollutants would be primarily local and regional. However, it was reported and warned the governments that the effects of massive smoke cloud could spread as far as India. The same author also pointed out, while the smoke would not probably have a global effect, nor cause a failure of the monsoon, the amount of smoke produced would be large and cause a massive pollution. Christopher Flavin, vice-president of the World Watch Institute "warned that oily smoke spreading to India and Pakistan could damage crops, grazing land as well as water supplies. Meanwhile there have been reports of "oil rains" as far away as Qatar 645 km to the south and blackened snow has been seen as far away as Kashmir 2,600 km to the east. Oil coats have found on palm leaves, starved from sunlight's, Black snow greeted skiers in Kashmir and black rains fall in Saudi Arabia and Iran. [14]

However, the most important concern arose from the oil fires smoke was human health. It is obvious that, it has already affected in ways and

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[14] Schiefer, n. 4, p.11.

degrees perhaps never to be known with certainty. Respiratory ailments appeared to be increasingly marked. Researchers were worried about carcinogen in the great smoke cloud. In Kuwait physicians felt, that there is an increase in the cases of asthma and reversible chronic obstructive lung disease. They also observed an irritation of eye and upper air passage. A survey from local residents during 1991 April showed that the people complained of headaches and eye irritation. The Analyses Science Cooperation (TASC, 1991) estimated a 10 percent increased in the sickness symptoms takened after two month of exposure smoke of the total patients from "Al-Adan Hospital". It shows an increase in respiratory incidence from 15.9 - 28.3 percent and in asthma from 5.7-6.7 percent from 1986 and 1991.

The joint study by Kuwait Institute of Scientific Research (KISR) and Dubai Institute of Environmental Research (DSER) concluded that in incidence of obstructive restrictive or mixed type of lung dysfunction was statically higher and more common in female than in male. However, because of the small number of sample more systematic studies on health impact are required before any final conclusion can be made.

Emergency Room Surveillance

Condition	Before oil fire %	After oil fires %
Hypertension	4.17	8.3
Heart disease	2.8	5.2
Dizziness	0.08	1.1
Drug allergy	0.04	0.5
Chronic bronchitis	0.84	0.5
Gastrointestinal disorder	19.6	23.2

Source: U.S. Public health service reports June 1991.

Monthly statistics that was collected in Al-Ahmadi Hospital during the period April-Sept 1991 was on the respiratory problems. From this survey it was reported that, after exposure to pollution respiratory problem was significantly increased than that before exposure (1987, 1988, 1989). This resulted from exposure to smoke and gases emitted from burning oil wells.[15] Yet, a complete exposure analysis programme required defining total exposure and doses from all (soil, food, water, seafood, air and plant)

Members of the US inter-agency team visited hospital in Kuwait and confirmed that some people, especially those suffering from asthma were at risk from pollution. They advised that troops should not be given heavy physical work within smoke polluted areas and should be provided with facemasks. Since, in this situation people were breathing in soot. Same

[15] El-Baz, n.1, p.108

observation was also made by a worldwide contingent of scientists who shared concern for this war's lingering impact on human health. They say, level of pollutants in the aircraft, particularly sulfur dioxide, was high enough to cause throat irritation.[16]

The American soldiers deployed in the Persian Gulf in 1990 to liberate Kuwait, complained variety of problems related to "gulf war illness." These include memory loss, headaches, blurred vision, chronic fatigue, sleeps problem, mood swing, skin rushes, aching joint, abdominal pain and diarrhea. Some veteran's spouses also noted similar health problems. They also become aware of what appeared to be an unusual number of birth defects in babies born to Gulf war veteran parents.[17]Though the coalition armies did not suffered heavy casualties in the Gulf War. Of the 355 US soldier died, 207 died in noncombatant accident.[18]

Ways and degrees cannot be measured with accuracy as to what extent Kuwaitis and its surrounding people have been affected from the smoke. The data that flows through was inadequate. The ministry of public health was inoperative soon after the invasion and fleeing of expatriate health workers.[19] This has put the wheel of Health Care almost to a haul. Mr. Kuawash, a professional nurse, in charge of the emergency room at the oil-

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16 Sylvia A. Earle, "Assessing the Damage One Year Later," *National Geographic* (Washington D.C., 1991) p.129.

17 Thomas E. Shriver, "Environmental Hazards and Veteran Framing of Gulf War Illness," *Sociological Enquiry* (Austin, 2001) p. 409.

18 James F. Dunnigan and Austin Bay, *From Shield to Storm* (New York: William Marrow and Company, 1992) p.342

19 Ibid.

company hospital said "we are treating many more bronchial and asthma cases." A lot of cases on coughing and upper throat infection were reported.[20] These were the most visible sickness arose from the burning of oil-wells fires smoke. Hardly any one could not escape the effect. However, people suffering from asthma were at more risk especially, a small sensitive population, consisting of the elderly, infants, and individuals with cardiovascular and pulmonary impairments, some hypersensitive individual are endangered from the smoke.[21]

The people of Kuwait not only encounter ailment from the smoke. Mr. Kawash said, Kuwaitis felt intense anxiety about carcinogens and other known chemicals that might larks in the hovering smoke. Acidic smog caused breathing problems. Naji's seven years old daughter was taken to hospital for the same reason. The smoke had mixed with humid night air to form sulphuric acid. Respiratory problem, allergies, migraines and persistent cough, eye, noses throats and lung irritant were the other common ailment that arises from the smoke. The smoke was so thick in as much 1991 that Kuwait city has plunged into darkness for two days. "Its hard on children" said Mr. Kawash, "when they play outside, they turn black, like little car mechanic we can't let go any whose for in fear of mine's and live cluster bomb. These entire factors could not help but have a psychological impact as its inhabitant. Meanwhile, Dr. Fatima

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[20] Canby, n.2, p. 12.

[21] H.W. Church, *Potential Impact of Iraqi Used of Oil as a Defensive Weapon* (Albuquerque, New Mexico: Sandia National Laboratories, 1991) pp. 120-121.

Bulbara, of the Al-Ahmadi hospital, commented it was possible that women were losing their hair as a result of the extreme pollution.

Oil Droplet and its Danger

Pollution from smoke not only keeps the Kuwaitis from perpetual gloom but a fine mist containing droplets of unburned oil constantly afflicted them. These conditions become increasingly even more intolerable as the weather gradually warmed up. However, the most serious concerns from the mist containing droplets of unburned oil, crude oil or petroleum, or hydrocarbon is very complex mixture of aliphatic, polyphonic and aromatic carbon. H. Bruno Schiefer, pointed out, the higher the viscosity (e.g., grease, heavy oil) the lower the toxicity as incidence of adverse health effect, with one exception, inhalation of oil droplets will lead to lipid or oil pneumonia. Petroleum or hydrocarbon can enter the body through the oral coetaneous and inhalator routes. He cited an illustration in explaining the above following studies especially, primary eye and dermal irritation test in Rabbits; dermal sensitization studies in Guinea Pigs acute oral Toxicity Test with rats, acute and sub-acute dermal toxicity test. The conclusion was, the mist containing droplets of unburned oil was:

1. Heavy fuel oils produced the most severe signs of eye irritation but short duration only.
2. Middle distillates produced severe dermal irritation.
3. All oils were, non-sensitizing.

4. Heavy fuel oil was most toxic after oral application.
5. Hydrocarbon causes mucous membrane irritation, vomiting and CNS-depression.
6. Inhalation of hydrocarbon causes cyanosis, tachycardia, tadiypnea, hematuria, hepatic enzyme, derangement, cardiac arrhythmia and renal tubular nephropathy, and may lead to renal tumor.
7. Damage erythrocytes are most evident in avian species, but not so evident or important in mammalian species.
8. It appears quite believable that corneal opacity ("clouding of the eye") occurs in some animal species after exposure to H_2S, making it difficult for the animals to find food, or to orient themselves.
9. With respect to cancer causing properties, there is unanimous agreement that in hydrocarbons are point's inducers of enzymes, which may pave the way for cancer. This start after dermal application, when permutations absorption occurs. Mixed function oxides (MFOs) were reported to be activated after application of Kuwait crude to the skin of rats and application of such oil to the skin resulted in skin cancer, with Kuwait oil creating tremors more rapidly than other oil.

A probability of increased cancers, but probably no more than what can be expected from workers in the oil industry or resident livings close to sites with such industrial activities.[22]

[22] Schiefer, n.4, pp. 137-138.

Inhalation of this oil particles alone, will lead to what is known as lipid or oil pneumonia. This is a very serious case that cannot be treated or slow down says H. Bruno Schifer. Most people react with diseases in pulmonary function due to concentrations of carbon disulphide that (CS_2) causes intoxication (damage of brain, eyes, and ears, cause's coronary heart diseases and endocrine and reproductive system damage) after prolonged exposure to vapor concentration.

The mist containing droplets of unburned oil caused gaggles and choking. Respiratory trouble was report far away from Bahrain other than Kuwait. According Bruno Scheifer, the SO_2 level in Kuwait was considered safe, judged from the U.S. Standard.[23]Numerous respiratory problems, such as bronchitis and asthmatic reactions Kuwaitis suffered, cannot be considered as particularly serious. Any major fire, even forest fires in Canada will produce similar effects.[24] Nevertheless, these contentions did not go uncontested. Haluk Ozkaynak an expert in air and public health says, "as a person who is worried about health effects and work in the field of environmental epistemology. I would be extremely cautious about claiming that there is nothing to worry about from air pollution impacts." According to John, S. Evan, "the air pollution measurement taken to date does not provide an accurate picture of exposure to pollutants from the fires. Random errors in exposure measurement have the effect in epidemiologist of biasing towards the null that is, failing to

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[23] Canby, n.2. p. 35.

[24] Schiefer, n.4. p. 140.

find effects even when they are present. Relative dead from the effects of fires roaring in Kuwait, according to his estimation, four or five death per day, compare with 250 per day in London fog death.

The uncertainty that prevailed was largely attributed to the White House decision to control environment and health information. Government attempts to cover up. It was pointed out by John Hargan that, "during and after the war, Satellite photographs showing smoke patterns from the region were withheld by the U.S. government. For example, the National Oceanic and Atmospheric Administration (NOAA) were kept from publishing many of its satellite photos. Meanwhile on January 25, 1991, researchers at Lawrence Livermore National Laboratory (LLNL) received a memorandum silencing discussion of the environmental impacts of the war.[25] Not only to researchers but also to journalists and even scientists were disallowed copies of satellite photos of the fire.

Lara hilder, aerosol chemist says scientist organizations and funders think the studies are newsworthy. This process is time consuming; it's typical for six months to elapse between time of submission of an article and its publication. A year would not be at all unusual. So, in the normal publication time span, the gag order would have been irrelevant.[26] Even raw data from the flights exists on computer files a lot of it is not going to be available because

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[25] *U.S.Environmental Protection Agency*, National Oceanic and Atmosphere Agency, Kuwait Oil Fires; Inter Agency Interim Report (Washington D.C., 1991) p.93.

[26] Ibid, p.96.

there is not enough money to analyze it. Fires are out, little incentive existed for government funding of path analysis has evaporated.

Ozone depletion and Human Health

Another life threatening danger that arose from the burning of oil wells was the Ozone layer depletion that caused concerns to all the knowledgeable being. Ozone layer shield protects from the danger of ultra-violet ray. Without this ozone layer shield, numerous ultra-violet radiation effects will endanger both human being and vegetations. These are related to the release of carbon and hydrocarbon from the burning of oil wells, which will lead to O_2 deficiency. Oxygen is the vital gas, which is needed by all living being to survive. Oxygen deficiency will lead to Ozone layer depletion says Solan Sakhuja.[27] The maximum concentration of ozone presents 24 km above the earth surface. The higher the concentration of ozone the greater is the shielding efforts, which is between 295-325 nm. It is this level the response of human skin response best to solar radiation. The range of radiation is described as "biological spectrum". If this radiation reaches, the earth surface without ozone protection the most common effect on human would be sunburn or erythematic. The lifetime exposure would cause permanent damage to DNA, which might mutate.

If the ozone layer is disturbed there will be many effects on the

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[27] Solani Sakhuja, Surinder Kaur and K.G. Mukherji, "Gulf War and Its Impact on Environment," *World Affairs* (New Delhi: 1991) Vol.2-3. p. 43.

biosphere. There will be imbalance radiation that will have severe impacts of the ecosystem like the increase in temperature, change in monsoon winds resulting in unequal distribution of rainfall pattern.[28] The Sea level will increase due to melting of ice caps; so low land areas would be submerged. On the other hand, oil well fires burnt continuously for months, these directly related to an increase in the atmospheric temperature causing "Global Warming". This global warming will cause melting of the earth's ice cap, which will lead to the flooding of lowland coastal areas, and most of the productive land will turn non-productive due to this flooding. Besides, there was a prediction of climate change of the region from the release of oil into the sea that would affect the monsoon, by forming a layer of oil on sea surface that cause less evaporation of water. Ocean to-land monsoon winds would be affected because of the increased temperature due to burning of oil and as a result there will be unequal rainfall. The effects may not affect the present generation, but the question loom larger for it is the matter of human survival and ethnicity on this globe.

Effects of Oil on Food Chain

Men and nature interact closely at various levels; impact on atmospheric environmental structure will directly or indirectly affect Human functions and activities. It also derived from nature varieties of food items to

[28] Ibid.

keep our body functional for which human being depends on nature. Though, "How much of the atmospheric / air pollution in Gulf region may eventually entered the food chain is yet to ascertain". Out the general question that people feared and concerned were, will they enter the food chain (via marine animals) and pose a threat as cancer causing agents? Let's hope for the best, that microorganism? Will it be able to reduce such PAH's to basic components.

The first important concern from the oil spill was the question of safe drinking water. Captain Don Jonsen, a veteran of oil spill clean ups and former head of the Exxon Valdez operation Alaska, who entered Saudi Arabia as the director of the U.S. Team, emphasized that luck plays, a major part in such operation. 'Certain wind condition could produce a very high risk that the spill would penetrate Saudi Arabia protective barriers and contaminate key water purification plants. It could affect drinking water, he warned. On February, 1991 Abdullah Dabbagh, Director of Research at King Fahd University of Petroleum an Minerals, stated that he could not guarantee protection of the Al-Jubail desalination plant which supplies 80 per cent of Riyadh's drinking water. He explained that oil could precipitate into the water column, which feeds the plant and admitted they do not have enough equipment to prevent vital water desalination plant from being polluted and expressed it as very serious problems.

According to Solani Sakhuja, the spillage has caused first and foremost drinking water problem in Kuwait. She pointed out that, under normal condition water is first purified and then used for drinking purposes. By

leased of oil it has become unfit for drinking. This was particularly serious with particulate matters input to water tanks (reservoirs), posed a serious health concerns in the presence of the chlorine; trinalomethanes (THM's) may possibly from the reaction with polyromatic hydrocarbons absorbed onto the particulate matters. On the other hand, the soil that was destroyed by thousand of tonnes of oil gushing from erupting wells and subsequent extinguished, a part of which could also penetrate into underground water and make it unusable for irrigation and human consumption. The seeping oil could taint Kuwait's ground water. Plant Geneticist Bikram Gill of Kansas State University sees a danger to ancestral grasses that may hold genes important to cereals like wheat.[29]

Kuwaitis were exposed to pollution from what they ate, drank, breathed and touched during oil fires says Farouk El-Baz. The threat looming large to human health from the oil fires and spilling of oil comes from aerial disposition of soot on surface of vegetation and soil. This will create continuous sources of pollution during the suspension of particulars contaminants or consumption of local farm produced. The vegetables were dead from the coating of oil and lack of irrigation water. Not only that, some of the airborne metals will settle on the ground especially in the vicinity of Kuwait, contaminating both soil and vegetation. Sheep, goats and camel grazed on contaminated grasses would accumulate metal and entered into the food

[29] Canby, n. 2, p.32

in. Many are carcinogens, which may cause brain damage and diovascular disorders.

Table 2: Heavy Concentration of μg/g in dust sample collected From Air Conditioner filter

Sample No.	Cd	Cu	Co	Fe	Pb	Mn	Ni	Zn
AC-1	ND	103.7	ND	91.581	306.375	467.643	106.708	602.715
AC-2	ND	64.823	ND	57.293	250.692	341.221	181.455	519.697
AC-3	ND	186.309	ND	63.43	368.607	362.997	154.795	2194.60

Source: DIER/ KISR, Joint Study 1991

Soil sample were analyzed through the joint activity of DIER and KIER. Several organic peaks were detected and further analyses are required for the qualitative identification. Soil contamination with those heavy metals has not been studied so far in Kuwait. The soil covered with soot might have received increased amount of nickel and vanadium from the atmospheric fallout.[30] The compound that persist in the environment, degrade a function of the physical chemical and biological elements of the ecosystem that influence its fate and toxicity, the PAH's pose a serious threat to health because they are among the lipophilic compound, that have high resistance to biodegradation and not readily excreted from the exposed contaminated organism and hence, could transfer from the lower level of food chain to top predator and subsequently human.

[30] Kuwait, n.6, p. 54.

The KISR initiated a study in July 1991 to determine the levels of pollutants in fishes and shrimp in Kuwait. When marine environment is exposed to high oil concentration in the vicinity of significant oil spill, meat fishes and shrimp will be tainted, this alert the consumer about the possible contamination of that food because of its odour and the presence of oil. In additions regular analysis of the fishes and shrimp can ensure quality characterization and advise people to desist the seafood, if the concentration of contaminants exceeds acceptable levels.

In the course of carrying out the oil contamination examination, eight species of fish and one shrimp species were collected at local fish market and was analysed for heavy metals and petroleum hydrocarbon concentration by KISR in July 1991. In almost all species they detected the levels of heavy metals are higher than maximum world ranges, however, rarely exceeded the maximum.

Besides, marine food contamination, the oil droplet contaminate animals product also likely to affect human health. Sheep's were covered with a black layer of oily soot. Some slaughtered sheep (recently) had blackened lungs, while other had blood blots in the lungs. Chemicals from the fires will enter the milk of sheep and diary cattle through respiration and feed by oiling the udders.[31] Even the hen stopped laying when the smoke comes, the rooster also stopped crowing.

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[31] Canby, n.2, p.12.

CONCLUSION

The state of affairs continued for some five to six months. The life style of several communities was disturbed. With tensions and anxiety growing by the hour people were unable to lead a normal life. Industry, business, farming, hunting as well as others were out of town. Activities stopped with several hundred thousand soldiers were collecting in the small state, adding to the fright and anxiety of the remaining resident. All ecosystems were subjected to abnormal conditions and stress. "Noise pollution from air raids, long distance missiles and rocket various other technological offensive weapon from the war make life unbearable killing, fires, smokes destruction and every kind of ruin happening. This was followed by chaos and anarchy when several hundred thousand of fully mobile and equipped soldiers were either entering Kuwait across the border or retreating from it.

The condition of stress and anxiety was further aggravated by the disability problems. Although classical warfare itself affects mainly men, "the gulf war 1991 affected women and children even more". Many women and children were disabled, Gulf War 1991 affect the Kuwait Children much more. They are still feeling the psychosocial Trauma. UNCEF Team report dealing with the health and nutritional needs of children in Kuwait suggested that the volume, stress and anxiety generated by the war had caused children trauma and loss, which will necessitate both short and long-term rehabilitation programmes.

CHAPTER – II

IMPACT OF OIL ON MARINE ECOSYSTEM GULF WAR 1991

INTRODUCTION

The Persian Gulf constitutes a body of Shallow Water Extending from 1000 km long, 300 km wide and an average depth of 35m. It is one of the most productive plankton water bodies in the world at the same time it is also regarded as one of the most fragile and vulnerable marine ecosystems. Its low tidal displacement means that it has little discharge of its water into the Indian Ocean and thus, little opportunity to flush out pollutants.

However, the inflow of nutrient rich fresh water from the Euphrates and Tigris Rivers through the Shatt al -Arab water way deposits its silt load in the extensive mudflats and salt marshes at the head of the Gulf. This together with clear warm waters, good light penetration and shallow depth encourage the growth of coral reefs, the most productive marine habitat, which contribute to the production of plantation that support the food chain of fish and birds. It also supports marine habitat, coral reefs, seagrass beds and number of key terrestrial habitats, including rivirine marshes.. These become history after the Gulf War 1991, when marine biological life was disturbed by oil spill.

An oil spill in the Gulf has serious effects on marine life because the Gulf is small and shallow, has slow circulation, and

biologically productive. The Arabian Sea, includes the Persian Gulf area has the highest marine life productivity in the world. However, the oil has threatened the whole marine ecological structure from marine food chain to reproductive system and reduced the resistance level in the struggle for survival of the fittest within their environment from oiled Persian Gulf. For instance, toxic hydrocarbon affects the seagrasses by contaminating the sediment; oil penetrates stomata and could lead to death of the plants. Seagrass bed provides the nursery grounds for commercially important shrimps. The toxic residue of partially degraded oil affects the young shrimp. Seagrass bed also provides food and habitat for a wide variety of marine organisms and major contributor to the productivity of the Persian Gulf. Coral reef communities that occur in three Coral Island of Kubbar, Qaru and Umm Al Maradim, close to the surface were put to risk from direct oil impact especially, when oil coats the coral during extreme low tides. This is likely to affect number of animals depend on them for their survival.

Causes of the Pollution

The consequences on productive marine environment arose from two main factors. First, the gushing of oil into the Persian Gulf, numbers of burning well have begun to extinguish naturally through the coning process. Coning of the burning oil well occurs when oil burned off faster than replacement of oil can move in the surrounding oil strata. This ensures that the less viscous water-oil mixture does not burn properly so the flame

goes out. Sometime after the extinction, these oil wells continue to gush crude oil and the flow was directed towards the sea. Attempt was made to reignite the oil spill even at cost of creating more atmospheric pollutants because it is better for the marine ecology and desalination plants than not burning. The burning helps to remove the most volatile oil compound that is more soluble in water and hence the most toxic. The natural drainage from land was tower the coast and it formed large number of oil lakes in the desert.

Earth containment dams were constructed across valley to make new oil lakes to protect roads and oil flows towards the sea. The potential input from this flood into Persian Gulf was estimated at 60,000 barrels per/day from central fields and 20,000 barrels per/day from the northern fields. "The Sheen" on the sea surface appears when the oil surface film is less than 1.5×10^{4} millimeters in thickness.[1]

Particulate from fires has been deposited on both land and sea over wide areas. During the UN mission visit, samples were collected and the analyses were made. It was found that the effects and consequences of carbon deposits on the sea were clearly visible from the death of fish, crabs and plant. The long-term consequences of this carbon deposit are also not known. But the eye witnesses estimated that between a third and a half of

[1] *Kuwait: Report to the General Secretary on the scope and nature of damage inflicted on Kuwait Infrastructure During Iraqi Occupation* (Nairobi: United Nation Department of Public Information, 1991) p. 30

the oil burned, at least 1,500,000,000 and possibly 2,000,000,000 barrels of oil returned to Earth and Sea, which added oil spill into the sea.[2]

Secondly, oil slick was another cause of marine pollution. From Kuwait Oil Company (KOC) log books, 10.7 million barrels of oil was in storage in 22 January 1991. Shortly after that date, the Iraqis reportedly released the oil from the Tank Farms to the sea through the pipelines leading to the KOC Sea Island. They confirmed that there were three Iraqi oil tankers anchoring the North Pier, each of 20,000 tonnes of crude oil capacity, with total maximum of 600,000 tones or 4.2 million barrels. The crude oil in the ships is said to have deliberately unloaded into the Persian Gulf. These constituted the greatest slick in 1991 Gulf War into the Persian Gulf. "Large portion of the slick has quickly evaporated. The remainders under weathering effects and degradation had diminished and broken into small patches, which moved southward and reached the Saudia Arabia water in a much lesser amount of approximately 1 million barrels.[3] This was clearly observed and confirmed by an UNEP expert mission to Saudi Arabia.

The Mina al Ahmadi Oil loading Terminal on Sea Island, some 25 miles Southwest of Kuwait City and Al Khafji oil storage ten miles South of the Kuwait/Saudi border significantly polluted the coastline. The former

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2 T.M. Hawley, *Against the Fires of Hell: The Environment Disaster of the Gulf War* (New York: Harcourt Brace Jihanovich, 1992) p. 142

3 Kuwait, n.1

on 30th January reported 50x15 miles in extent covering an area of about 750 square miles, although size estimate range from 350-900 square. The slick extent southwestward, into Gulf, and carried south into Saudi waters by the current at a rate of about 15-20 miles a day. The later, where the slick was some five miles long, and has polluted the coast South of Khafji. The Saudi coast from the Kuwait border to the Gulf of Bahrain has a discontinuous strip of coastal coral reef, was in imminent danger of inundation in the khafji/Mishab region.

The result indicates heavy impacts of oil on the coast extending from Al-Ahmadi in Kuwait (Latitude 28'45°N) to Abu Ali Island in Saudi Arabia (Latitude 27'10°N). After 80 days, the results showed that the initial volume of the oil spill, 45 percent hit the coastal region between Al Ahmadi (Kuwait) and Ras Abu Ali (Saudi Arabia), 32 percent evaporated, 15 percent sink to the seabed, and 7 percent remained on the sea surface. A small fraction of the oil, about one percent dissolved in the water, which has significantly affected the environment.[4] Urgent measures were taken to protect the desalination plants and the petroleum related industrial complexes, which are vital to the region.

The world conservation union expressed the same concern, when a large oil spill happened. According to them, "This fertile but vulnerable

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4 H. Bruno Schiefer, (ed.) *Verifying Obligation Respecting Arms Control and the Environment: A Post Gulf War Assessment* (Canada: University of Saskatchewan: Saskatoon, 1992) p. 11.

marine environment is likely to create one of the worst marine ecological disasters to date. In size it dwarfs the Exxon Valdez spill in Alaska, and because of the biological richness of the gulf waters it is likely to have much more serious ecological repercussions.[5]

Much of the oil degraded by biodegradation or when photochemical reactions take place quickly in the warm temperature. Oil sediment on the other hand, persist for a long time and endanger the food chain through species such as shrimp, which feed on the Gulf bottom. Thus, there is a potential impact for long-term fishing industry as well as general ecological disruption.[6] This was one of the reasons, why burning of oil was considered as better option for marine ecology and desalination plants than not burning even at cost of creating more atmospheric pollutants, as better option.

In the absence of any concrete data on the effects of chronic oil pollution to different species, Boyce Thorne Miller illustrated with Nowruz spill effects 1983. She analyses how marine mammals (porpoises and dugongs), sea turtles, sea birds, sea sneaks and fishes were killed. Seeing that condition she believed, the spill at the Mina Al Ahmadi could led to the collapse of the whole marine communities. Besides, the immediate

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5 World Conservation Monitoring Centre: "Gulf War Environmental Information Service: Impact on the Marine Environment" The World Conservation Centre is a Joint venture between the three partners who developed the world conservation strategy: IUCN – The World Conservation Union Environment Programme and WWF – Its mission is to support conservation on the world biological diversity. *http///google.com.unepkuwait*, Date 14/5/2004

6 Saul Bloom (ed) *"Hidden Casualties: The Environmental, health and political consequences of the Persian Gulf War"* (London: Earthscan Pub, 1994) p. 50.

asphyxiation and oiled of numerous animals, the dissolved hydrocarbons harmed the sensitive larval stages in the water. The solid phase that settle and mixed into the bottom sediment also retarded the re-establishment of healthy communities. The victims of this and possibly other spills affect the diversity of species and ecosystem.

The species fished by the counties surrounding the Gulf may suffer great losses, particularly among juvenile and larval population, which affects the catches for the next year to several years. The eggs and larvae of marines are very sensitive to the effect of pollution.[7] A gigantic oil spill such as the Mina Al Ahmadi spill, occurred in winter, are expected to take a heavy toll on both adult and larval stages of important fisheries species.

Oil spills are also lethal to inter tidal areas such as the broad mudflats. The small invertebrates in the mud dies or become contaminated. With oil the wading birds feeding there ingest those contaminated animals so that they in turn die or become ill. Coral reefs exposed at very low Tides would be smothered by oil left behind by receding water.

In the shallow areas of restricted exchange with ocean waters the effects of an oil spill may be more extensive and long lasting, at least from the perspective of those measuring the effects. The extensive seagrass beds are particularly vulnerable, as they serve to trap the oil. The fact is that the highly toxic volatile fraction evaporates rapidly especially, in warm waters.

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[7] Ibid.

However, the Gulf Waters are not very warm in the winter (50°–55° F) and the dynamic mixing processes will maximise the dissolution of hydrocarbons. While a large portion does evaporate, the damage that can be caused by the remaining dissolved and solid material should not be underestimated".[8] Organisms contaminated by hydrocarbons (ingested or absorbed) often become less resistant to other environmental stresses. Since this is an environment of extreme, many of the species are functioning very close to their tolerance limits. The effect of the oil contamination is reducing their physiological tolerance to their natural environment.

Impact of Oil on Fish

The marine environment constitute a major component of natural environment and has many dynamic interaction with other component[9] oil spillage therefore, affect aquatic life by forming a thin layer on the surface of the sea, cutting oxygen supply, causing death to aquatic animal life. The most visible effect according to Solani Sakhuja, oil will get accumulated in the gills of the fishes and make them inactive, disturbing the whole food chain.[10] In many coastline from Al Mina al Ahmadi terminal in Kuwait Southwards to Qatar, a coast length of some 500 miles support several

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8 World Conservation Monitoring Centre. "Gulf War Environmental Information Service Impact on the land and Atmosphere. *http///google.com.unepkuwait*, Date 12/5/2004.

9 "State of the Environment in Asia and the Pacific 1995", *Asian Development Bank* (United Nations: New York, 1995) p. 112.

10 Solani Sakhuja, Surinder Kaur and K.G. Mukerji, "Gulf War and its Impact on Environment," *World Affairs* (New Delhi: 1991) Vol. 2-3.

hundred species and providing the spawning ground for several commercial fish species. "Around Manifa, Tarut Bay and Dawhat Zaium in the Gulf of Bahrain support a myriad of marine species and provide valuable spawning and nursery grounds for several fish species of commercial value. These commercially important fishing areas support an extensive traditional fishing industry of considerable important to the local economy. Kuwait like other state in the region derives most of its income from oil; yet, the fishing industry continues to be of economic and cultural importance. Some communities still subsist on near shore fishing industry and focus on the capture of near shore species, the shrimp (pinacus semisulcatus) and hammor (Epinephe lustaurina) Fishes are particularly important. Traditional fishermen were also severely affected. When UNEP mission visited Kuwait fishing activities were ceased completely, which is second only to oil in their economic importance. Kuwait also operates a traditional coastal fishery, which supplies the bulk of the local market requirements, although the amounts of imported fish have been increasing in the recent years.[11] Most of Kuwait's shrimp production is for export.

Seagrasses play a key role in maintaining the productivity of local fisheries; a number of commercial fish, shrimp and pearl oyster feed on these pastures. Oil pollution would kill the seagrass bed if it smothers the leaves and stems or it may damage the grass bed by destabilising the sediments. The oil can also cause glutinous conglomerates with the

[11] Bloom, n.6, p.6.

sediment, forming balls, which, with their increased buoyancy are more susceptible to wave action, so that eventually the seagrass becomes uprooted.

Seagrass typically grows in the form of submarine pastures in the shallow inshore water. This seagrass pastures are vital feeding areas for shrimp fisheries and spawning. Seagrasses are prone to physical and physiological damage by oil pollution, and certain species are known to have affected adversely by dispersants commonly used to combat oil spills. Seagrass ecosystems represent one of the most critical marine habitats and in the Gulf that provides food or shelter to more than 500 species of plant and animals. The worst scenario was that critical habitats such as seagrass bed had become heavily coated in oil, and that further releases the highly toxic chemical result in the wide scale mortality of marine life. The eggs and larvae of marine invertebrates are sensitive to the effect of pollution, and disrupt the productivity of marine ecosystems and fisheries they support.

John McCain (research institute of King Fahd University of Petroleum and Minerals) says, 'As a result, unique physical and biological promote vigorous growth of sea grasses and algae at the bottom, along with plankton in the water. For thousand of years this productivity has supported fisheries of shrimp and fish like mackerel, mullet, snapper and grouper".[12]

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[12] Thomas Y. Canby, "After the Storm," *National Geographic* (Washington D.C. 1991) Vol.18, No.2, pp.16-17.

The coastline hit by oil spill shows the possible decline in Gulf fisheries. Juvenile fish and shrimp died because of the destruction of nursery habitat; other sea life along the shore was also killed directly. This can be clearly seen from the dead fish scattered on the beach; dead cormorants, dead grebes, feathered shapes too encrusted to identify.[13] Many fish also died, in some localised areas such as around the heavily impacted Gurman Island. Here, the impact was so severe that all types and sizes of fish were killed.[14] It's a relief that they have died,[15] says, Tony Preen an Australian biologist because oil-soaked surface, wrinkled like a rug.

Moreover, fisheries of the Gulf were affected by the acute toxicity. The oil killed the fish, shrimp, pearl oyster, plankton marine eggs and larva by destroying the spawning grounds (in laboratories mortality of fish eggs from surface oil film was 70-100%). At the same time, mat-like sheets of oil have settled on the bottom of the Gulf says El-Baz, which destroyed the shellfish spawning ground and suffocated the coral reefs.[16]

Kuwait Institute of Scientific Research (KISR) initiated a study in July 1991 to determine the levels of pollutants fish and shrimps in Kuwait. It found out that when marine environment is exposed to high oil

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13 Ibid, p.30.

14 Michael Mickinnon & Peter Vine, *Tide of War: Eco-disaster in the Gulf* (London: Immel, 1991) p.112.

15 Ibid, p.27.

16 Farouk El-Baz, "Preliminary Observations of Environmental damage due to the Gulf War," *Natural Resources Forum* (New York: 1992) Vol. 16, p. 24.

concentration such as in the vicinity of significant oil spills, it tainted the meat of fish and shrimp.[17] Eight Species of fish and one shrimp species were collected at local fish market and examine for heavy metals and petroleum hydrocarbon at KISR Laboratory. Almost all the detected heavy metals are higher than maximum world ranges.

The Gulf fishing constitute second only to oil in terms of its economy. This fishing industry was seriously affected by oil pollution directly or indirectly by affecting the larvae, spawning and nursery ground. At the same time by uprooting the seagrass which is vital for fish survival. As the long-term impact on fish production is not manifested, it was found that, seven years after the war, the impacts of oil contamination on the marine ecosystems and livings species such as fish and shrimp are difficult to distinguish from the impacts of chronic oil pollution. Currently, the shrimp harvested each year are similar to the ones recorded before the war.[18]Yet the spillage had stressed the "jewels of Kuwait's Gulf water,"[19] marine life and coral reefs.

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17 Farouk El-Baz and H.M. Makharita, *"The Gulf War and Environment"* (Switzerland: World Trade Centre, Gardon and Beach Science, 1994) p.49.

18 "Environmental Legacy in Kuwait: An Environmental Assessment of Kuwait,"*Green Cross International Program http//www.gci.ch/green cross program/legacy/Kuwait/Kuwait 7 years htmp.*3/5/2004. p.2.

19 Kuwait, p.1.

Impact of oil on Birds life

Two million migrating birds of fifty species used to visit the Persian Gulf every year. This visit was made possible by intricate balance between all the organisms. For instance, the fine mud of areas such as Sulaibikhat Bay has enormous concentrations of organic matter within their sediments. The source of these nutrients is primarily silt washed down from the Tigris and Euphrates River. Bacteria help to break down the organic silts to form energy rich 'soup' nourishing algae and invertebrates. Fish and birds feed on these, beginning a food chain, which is many instances, ends with humans. This constitutes one of the important reasons for birds' migration to the Persian Gulf region (because mudflats provide the feedings ground for numerous species of wading birds). The beaching of oil on mud flats not only smoother the surface algae but also killed the fauna of worms and crustaceans upon which both fish and bird feed.

A major threat to seabird and for other diving and surface feeders such as ducks, grebes, cormorants and flamingoes was the smothering of plumage with oil and the ingestion of tars. For example, approximately 1,000 birds, mostly Socrota cormorants and white-checked terns were killed on Northeast Bahrain following a spill of 20,000 barrels of light crude oil. Thus, thousand of migratory birds made one-way visit into the alluring liquid.[20]

[20] Sylvia A. Earle, "Assessing the Damage One Year Later," *National Geographic* (Washington D.C., 1992) Vol.181, No.1, p.128.

Further, during autumn large flocks of great flamingos also arrive in the Gulf from the southern Russia and Northern Iran. Carrying oil on their feathers probably weakened many.[21] Swallows call bee-caters were hit hard on migration; they mistook the oil lake for water and tried to drink from them or landed in them. Diving sea birds (e.g. grebes and cormorants) into the oil spill were virtually wiped out in the first weeks of the spill. This birds are most vulnerable to oil spills because of their instinctive response to dive so they become too oily to fly. This dead and dying birds trapped in the oil became the easy prey of a large migratory hawks that scavenge them and in returned they were oiled.

Birds like Gulls and Terns are adapted to avoiding oil, and their casualty rates are relatively low. However, birds like Shorebird or Waders, even when their tail and feathers are oiled they still fly hundreds of miles away. Even if a shorebird is not killed, it reduced their fitness after oiled and spends a lot of time preening, which affects the skin.

Soot was another factor, which affected the bird. Burr Heneman says, "She could not identify birds along the coast because they were so sooty".[22] They apparently pick upoil up oil by going through the foliage when the rain comes in April and May 1991, the Saudi Coast was quite sooty and turned everything gray including the foliage on the shrubbery.

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21 Michael Mckinnon and Peter Vine *"Tides of War: Eco Disaster in the Gulf"* (London: Immel Pub, 1991) p.48.

22 Ibid, p.61

The birds get covered in soot from different ways. The important factors are, when they fly through it or by brushing against it while feeding in bushes. However, other factor also contributed equally in soothing the birds like, while drinking water their wings get stuck up with oil and got killed by any other animal or die an unnatural death.[23] A large number of birds were also killed when the dive into it oiled water seeking an elusive fish. The Saudi Arabia National Commission on Wildlife Conservation and Development (NCWCD) give a clear picture about the toxic component that affects the birds. First, it virtually killed all the invertebrate life and intertidal mud flat all along the stretch, which is about 50 percent of the Saudi Gulf coast shoreline. All the invertebrate life appeared to have been temporally wiped out. NCWCD sources said, the value of this area as a feeding and refueling area for shorebirds had been very severely reduced and says, they found very few shorebirds along this area.

Arial and ground survey along the entire oiled coastline in April and May 1991 also shows lesser than a thousand shorebirds. Indicating a reduction of more than 98 percent, it is difficult to know for sure how many were killed. The International Council for Bird Preservations (ICBP) survey in March 1991 by Burr Heneman found that, at least 50-75 percent or more shorebirds found in the oiled Zone were oiled. Bird rescue centre was sets up by Jubail Wildlife rescue centre and by the NCWCD to rehabilatate the oil victim birds.

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[23] Bloom, n.6, p.42.

UNESCO also organised workshop on how to rescue and rehabilitate-oiled birds. People were trained on clean up, medical and rehabilitative care of the affected birds. Only about 1,300 oiled birds were treated mostly of cormorant and grebes. It was not amazingly successful compared to the vastly greater numbers of oiled birds. Yet a lot of great cormorants were cleanup and released .All the birds that were released had a coloured band put on their leg. In November 1991, a couple of these great cormorant were spoted again along the Saudi gulf coast probably very close to where they were originally oiled, and picked up. So, this indicates that they obviously survived the cleaning process and migrated back to the Gulf successfully for the winter. That suggests for the cormorants any way that the cleaning operation was successful.

Dead Coral off Kuwait Beach

The Gulf Sea is shallow, the deepest areas are 30 m. Corals are found below 15 m and the most extensive formations occur at depths of less than 10m. U.S. National Oceanic and Atmospheric Administration (NOOAA) visited the Gulf and found a lot of the coral were dead in the north near Kuwait. This was reported at the January 1993 conference organized by Regional Organisation for the Protection of the Marine Environment (ROPME). They did not really know when it died or why? Did oil harm the coral?

The answer is still elusive, says Saul Bloom in the Book "Hidden Casualties". He emphasized the dead of coral mainly on 'stressed'; it may be also related to the cooling which the oil plume that reduced the overall temperature of the area influenced. A few species can tolerate a drop in temperature. For some period, the temperature was down to as low as nine to ten degrees. Therefore, they could not sustain it for long. It could be that sustained low temperatures as opposed to an occasional nip below a critical level caused some of these corals to response in the way they have or just make them more susceptible to other ills.

On the other hand, petroleum hydrocarbons have numerous detrimental effects on coral, including reduced reproductions, larval development and settling, growth rate, photosynthesis, cell structure, feeding behavioral responses. It is believed such effects are probably the result of hydrocarbon fractions being incorporated into water column; hence these problems can be exacerbated by the use of dispersants. A major threat also comes from the smoothening of corals by crude oil particularly during low Tides. This caused massive mortality, and possibility of toxic entering the food chain through coral feeding fishes.

Meanwhile, the coral were either dying or dead off the coast of Kuwait. However, in some places where the coral are bleached, yet the polyps are still alive, though the corals themselves are in bad shape, it has a hope of recovery. Functionally, coral support several hundred species and providing the spawning ground for several commercial fish species. Coral

reefs are the marine equivalent of the tropical forests in terms of their species diversity, and some of the richest reefs in the Gulf are under threat.

Condition of Turtles

Many marine species including marine turtles and marine sponges are threatened by the continuous deterioration of coastal water quality.[24] When the water quality was affected by oil spill, the most visible aspect was the disruption of the sea turtles life. Firstly, polluting the seawater by oil affected the food supply. Secondly, oil washed upon the coast has affected the ground for turtles nesting.

Firstly, Green turtles are entirely herbivorous as adults, it feeds on seagrasses, and on algae where seagrasses are not available and "The seagrasses grows in the form of submarine 'pasture' in shallow inshore waters.[25] They were adversely affected from dispersant commonly used to combat oil spillage. The seagrsses beds were also affected from oil establishing on the sediments. The oil caused glutinous conglomerates with the sediment, forming balls, with which their increased buoyancy, are more susceptible to wave action, so that eventually the seagrasses becomes uprooted. The University Miami indicates that the crude oil is quite toxic to sea turtles. Exposure to small amounts would mess up their liver enzymes.

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[24] *Global Environmental Outlook* 2000 (London: Earthsean, 2000) p.164.

[25] For further reference see, World Conservation Monitoring Centre, Gulf War Environmental Information Service: Impact on the Marine Environment. *http\\ www.google. com UNEP Kuwait*.14/5/2004, p.22.

These affected not only on Green Turtles that feed directly on seagrasses, but also on several species of commercial fish like shrimp and pearl oysters also dependent as their sources of food. Thus, the seagrasses represent one of the most critical marine habitats in the gulf that provides food or shelter to more than 500 species of plant and animal.

Secondly, the factor that affects the life function and reproduction system of the turtles was the disruption of nesting ground by 'oil washed up on the beach. Small or moderate amounts may pose immediate threat to the emerging females, but significant layers of oil on the nest beach would probably make nesting very difficult as well as impossible.'[26] The islands were badly oiled and littered with debris that the amphibians would scarily able to lumber ashore and dug pits.[27]The situation in Saudi Arabia islands used by Green Turtles was affected by substantial volume of marine debris and oil washed up with the prevailing drift from the north. Nesting sites in the straits of Hormuz was also affected by oil spill and bombing. Debris makes emergence and nest formation more difficult.

Other places, like the Kuwait offshore of Quruh Island renowned for its coral reefs and sandy beaches, which is the only, nesting area in Kuwait for Green and Hawksbill turtles are also threatened by the oil slick.

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[26] Greenpeace International reported that eighty percent of the Beeches of Karan and Jana were covered with oil. See Greenpeace International, *The Environmental Legacy of the Gulf War*, (Amsterdam, 1992).

[27] Thomes Y. Canby, "After the Storm," *National Geographic* (Washington D.C., 1991) Vol.18, No.2, p.28.

Besides, threatening the procreation process of Turtles, 'waterborne oil presents a long – term health hazard, particularly to hatching and smaller turtles, skin lesions and complete blockage of the mouth, throat and exposure to even small amounts of crude oil probably kill the eggs are among the documented effects. Oil washed on the beach may pose threat to emerging female.

"Unfortunately," sea turtles will not change their nesting beach. They are completely committed to particular location.[28] However, in long term, Perren Ross a biologist and a specialist on sea turtles conservation at the Florida museum of Natural History, Gamesvile says, the total execution of that group of sea Turtles is not likely. The biggest pervasive problem will be the destruction of their habitat.[29]

Conclusion

The Persian Gulf is effectively a rich and fertile inland sea, which is inextricably inter-related with the development and well being of the people around its shores. The discharge of a vast quantity of oil has adversely affected all the biological surrounding. The potential threat of further releases of toxic chemicals would have a major impact upon the ecological viability of the ecosystem and range of human activities they support. The worst scenario is that critical habitats become heavily coated

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[28] Bloom, n.6, p.65.

[29] Ibid.

in oil, and that further releases of highly toxic chemicals result in the wide-scale mortality of marine life.[30] The eggs and larvae of marine invertebrates are very sensitive to the effects of pollution; so further discharges are likely to severely disrupt the productivity of the marine ecosystems and the fisheries they support.

Apart from the obvious causes of direct mortality, many may simply migrate away from the disturbance area; more sedentary, or territorial species may stay and suffer disrupted breeding, slow starvation due to reduced time available for foraging.

[30] *http///www.gggle.comUNEPkuwai,.* 12/5/004

CHAPTER – III

OILED DESERT ECOSYSTEM IN KUWAIT

INTRODUCTION

Kuwait is an arid country with a harsh environment and a diverse biological heritage. The major part of Kuwait is a desert plain with sparse vegetation. There is a marked seasonal variation and yearly rainfall. The desert tends to be either in a rich green mantle in rainy years or devoid of vegetation in dry years. Usually it experiences cold winter when air temperature descends to almost 0°C accompanied by strong winds, rain and thunderstorms. In summer the weather is hot with a temperature ranging from 45-50°C. Lack of rain and strong northwest wind, locally called Shamal, produces dust storm in the desert and causes havoc to the desert weather.

The peaceful interaction among nature was completely shattered followed by Iraqi aggression on Kuwait after a year of peace from devastating Iraq-Iran war. The Iraqis seem to have adopted a potential scorched earth policy from the day they set foot in Kuwait. They demonstrated this policy by deliberately sabotaging the oil wells and setting on fire, which produced enormous quantity of smoke into the atmosphere and spilling into the sea and desert. Many more oil was spilled into the Kuwait: desert than in the Persian Gulf. The smoke returned to earth in the form of soot, oil-mist, acid rain etc. to Saudi Arabia and Kuwait.

Most people, when they think of the 1991Gulf-war, they think it in terms of the destructions of oil, loss of troops etc., but do not put on the balance sheet of the natural support system i.e., the environment. People in other parts of the world; usually tend to think that they should not be undue worry on environment damage in the Gulf as it is too far away from them to have any impact on their life. This kind of false consciousness has been widely circulated. It is however, important to know that environmental pollution has no national boundaries. This is clear from what had happened during the Gulf War 1991. We heard of the black rain pouring down in Saudi Arabia and Iran, black snow greeted skiers in Kashmir more than 1,500 miles eastward from Kuwait oil fires.

The surface area covered by oil soot and plumes was 943 km. Total surface area affected by oil seepage was 49.1 km from total surface area of Kuwait 17,818 km. The unburned oil formed a large number of oil lakes around and between some oil wells. Some of these oil lakes were 5 kilometres long and 1.5 metres deep. According to the petroleum division, Kuwait Institute of Scientific Research (KISR) estimate, 20 million barrels of oil were spilled in the first week of August 1991. Another estimate in the Saudi Arabia Gazette dated 26/8/91 put the figure at 156 million barrels. Area covered by wasted oil was 30 million sq.m. In the Burgan sector the largest measured oil

lakes was 12 by 6 kilometres.[1] In the vicinity of the burning oil fields, the environment has been trashed. Film of oil covers everything and blackens plants, soils, and the whole landscape.

Apart from sabotaging oil well, military-vehicular movement, digging of trenches, bunkers tunnels to hide soldiers, arms and ammunition and planting of landmines equally destabilised the desert ecosystem. However, it was not as threatening as sabotaging oil well. Thus, the main discourse will be how the burning and spillage of oil has affected the desert ecological structure.

The spectacles of burning oil wells raised many fears. Many dire predictions were made at that time as to potential desert environmental effects. These concerns include:

1. Modification of Global and regional weather patterns, including interruption of the Indian Monsoon.
2. Regional cooling and heating.
3. Regional precipitation modifications, including precipitation amounts, acid rain and black rain.
4. A large increase in the release of green house gases.
5. Potential groundwater contamination from the huge oil lakes around the wells.

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[1] See detail in Gaafar Karrar and Others, A report for UNEP. Iraq-Kuwait Conflict on Terrestrial Ecosystem the State of Kuwait. *http///UNEP.orgbh/regional. UNEP Kuwait.* Date 12/3/2004 p. 7.

6. The deposition of soot particles and unburned oil droplets on land coating and killing animal food chain from toxic deposit and metal species, particularly, nickel and vanadium.

7. Oil spill creating large oil lakes close to the burning oil fields.

8. The effects of smoke, from all the combustion products of oil.[2]

Contaminated Soil and its Danger

Looking closely from the prism of the 1991Gulf-war, "An oil contaminated Kuwait terrestrial ecosystem has reached a level of an unprecedented scale in the history of the planet".[3]However, the degree of oil contamination on the desert ecosystem is often difficult to assess methodically because of the absence of baseline data, political and scientific censorship. The intensity of impact on the desert soil structure can be studied from various factors including the type of soil, the ability to control the rates of evaporation, permeability of oil into the soil profile and the mode by which the oil reaches the organism etc. The entire factor depends on the states of oiling, like:

1. Soil type and micro relief affecting the degrees of oil on different organism.

2. Climate and whether condition.

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[2] H. Bruno Schiefer (ed) *Verifying Obligations Respecting Arms Control and the Environment: A Post Gulf War Assessment* (Canada: University of Saskatchewan, 1992) pp. 86-87.

[3] Environmental Legacy in Kuwait: An Environmental Assessment of Kuwait http///www.gci.ch/Green Cross programmed/ legacy/ Kuwait 7 years html/ Date 3/5/2004 p.1

3. Fire, change of temperature, oil pools, oil slicks, oil rain, mist and soot.

4. Cleanup measures, mini-field clearance and other reconstruction activities.

The oil fire was put out in eight months, but there was a period in which some of them were not capped. When the United Nation Environmental Programme (UNEP) mission visited three such wells in the Maqwa field, these wells continued to gushed crude oil, pouring out huge amount of oil into the desert. The outpouring of crude oil increased dramatically in March 1991. As a result, a large lake of crude oil was formed. Oil River flows everywhere from the well to the newly formed oil lakes. The mission observed oil erosion of land where Oil Rivers scour erosion gulley in the soil - a phenomenon that was unique in environmental observation.[4]

However, oil flows once causing a huge danger to desert soil and torrents of oil that blocked the roads was no longer a threat anymore as the earth-dams across valleys to make new oil lakes to protect the roads from oil flooding was working. The last gushing oil wells were also capped on sixth November 1991. Thus, the oil flood was reduced.

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[4] *Kuwait: Report to the Secretary-General on the Scope and Nature of Damage Inflicted on the Kuwait Infrastructure during the Iraqi Occupation* (Nairobi: United Nation Department of Public Information Pub, 1991) p. 28.

Identification and Assessment of the Impact of War Activities on Kuwait

Impact on Desert Soil

Activities /and Impact	Nature of the impact	Direct	Indirect	Temporary	Permanent	Reversible	Irreversible
Oil Pool	Submergence under oil leading to coating of soil particles and choking of pore spaces pollution contaminate -on with heavy metals.	*	–	*	*	–	*
Oil slick	Ditto	*	–	*	–	*	–
Oil rain	Sealing of soil surface to increase run-off, lack of aeration pollution	*	–	*	–	*	–
Cleanup of oil wells	Soil compaction, soil salination near the wells.	*		*		*	
Fire	Destruction of soil organic matters depletion of soil moisture	*	–	*	–	*	–
Soot airborne pollutant	Contamination of soil with heavy metal e.g. Nickel and vanadium, reduce aeration and permeability incrustation with acid rain may hinder seed germs increased run off	*	–	*	–	*	–

Table No: 1. Sources. Gaafar Karrar and others. A Report Prepared for the UNEP. *http\\www.gooogle.com unepKuwait*. Date.12/3/2004 p.52.

Reducing the oil flood was important but not the end of the environmental problem. Oil has coated the grasses and on the desert surface and then windblown dust has coated the oil. It looked like the environment was clean; yet, oil was still there and covered by a thin layer of windblown sand and dust. Thus, a blackened area was actually covered by sand and dust.[5] Similarly in the beaches also looked fairly clean, but when it was dug below the surface of some of these beaches, there was a veneer of clean sand covering a stratum of oil ranged from a couple of centimetres to a half.

Meanwhile, oil flows had been collected in the lakes, which in some places were hundred square miles and in some cases it was several metres deep. These oil lakes did not occupy a high priority for the Kuwaitis and now more volatile fractions have evaporated, leaving behind thick goo containing all the toxic residues such as heavy metal species. The oil ploughed into the land continues to remain toxic, because of heavy metal contamination.[6]

In other places, oil mist spread widely but thinly on the faces of the desert. In some cases, this has wide spread destructions of bio life. The colour of the soil surface turned dark grey to black. It gives the appearance of a lava field and coated with soil particles. This increased the capacity of the soil to absorb solar radiation and induced granulation in sandy soils and

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5 Saul Bloom (ed) *Hidden Casualties: The Environment, Health and Political Consequences of the Persian Gulf War* (London: Earth Scan, 1994) p. 130.

6 Schiefer, n. 2, p. 90.

sealed the loamy soil. High temperature and wind also caused this oil chemical substance to evaporated and react with water to form sulphurous and sulphuric acid which upon reacted with calcium carbonate present in the soil and produced calcium sulphate, that reduced soil alkalinity. Reduction of soil alkalinity leads to unavailability of most plant nutrient.

'Tarcrete' was another hydrocarbon chemical ('Tarcrete' is a conglomerated consisting of surface sand and gravel cemented together into a hard mass by petroleum droplets and soots), which covered the total desert surface areas, approximately 943 kilometres. This tarcrete basically stabilised the desert soil surface (like a new rock formation). In the past, petroleum sprays have been used to stabilise dune sands. From the sand point of view, tarcrete has a positive impact.[7] It also exerts a positive effect on run off and checks sand creep in the shifting sand areas temporarily. However, the tar on the soil surface has completely modified its chemical and physical characteristic.[8] It also adversely affected seedling emergence and water infiltration. Soil saturated along with oil inhabits aeration; such an absence of oxygen supply to the soils might not be easily compensated. At the same time the oil slick in the pools affects the soil properties especially soil-water relationship.

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7 Farouk El-Baz and R.M. Makharita, *The Gulf-War and the Environment* (Switzerland: World Trade Centre, Gordon and Beach Science, 1991) p. 155.

8 Karrar and others, n.1. p. 40.

Another major effect was the non-combusted oil particles that were propelled into the atmosphere. The plumes however, did not rise above the initial fear as it remained below 3 kilometres. The solar heating of the plume has warms up the plume. This has two effects: First, the plume tends to remain concentrated as winds converge on the plume, while it was rising. Second, the surface was cooled under the plume. Surface temperature was depressed to 10°C beneath high smoke concentrations was within 200 km,

and 20°C under the plume close to the wells. In fact Bahrain had its coolest May in 35 years, about 4°C below normal. Sunlight was reduced to near night time levels when the thick smoke was overhead. The shading has reduced solar radiation.[9] Agronomists feared that, harvest would fail from drastic reduction in the daytime temperature to five degrees Celsius below normal temperature for two to three weeks during the germination period.[10] The scale of soot in the atmosphere also dirtied the well seed from oil rain. The irrigated agricultural region of Al-Wafrah, close to the southern border, which produced an abundance of vegetable and fruits, including cucumbers for export to Paris had been declared dead for three reasons:

1. Because the village lost water supply;
2. There was a lack of sufficient light from the plume to almost totally bland keted photosynthesis for many days; and
3. The produce outside green houses was coated with oil drops,[11]

Oil escapes from burning well gets concentrated as toxic gases in the

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9 World Conservation Monitoring Centre. http///www.google.com.UNEPkuwait, p. 17.

10 K. A. Browning, "Environmental Effects from Burning Oil Wells" *Nature*, (Berlin, 1991) Vol. 35, p. 363.

11 Schiefer n. 2. p. 88.

atmosphere and fell to the surface as acid rain. It was as black as oil and contained considerable amount of SO_2 and acid precipitation (NOX's) had occurred in the desert and caused considerable impact on agricultural productivity. The oil rain also penetrated or seep through the fractured rock and polluted the groundwater aquifers beneath[12] making the water unusable for irrigation and human consumption. The oil did not percolate into the sand

but drained into the creeks and wadis, representing a long-term impact particularly on Kuwait agriculture, which depends solely on the ground water reservoir.[13] At the same time, the oil-saturated part of the soil depleted its moisture holding capacity. Taking all these conditions into consideration, the contaminated soil and water from the 1991 Gulf War fallout made the agricultural productivity of the available land renders less conducive for agricultural activities. This has paralysed the country's capability of producing its food calorie in take; in return it decreases the productivity of labour force.[14]

The threat also comes from compression of the desert soil, which precludes vegetation growth. This is especially so during the germination season which killed the upper life forms from its toxicity. Sludge also killed the deep life forms by suffocating and caused more ecological damage.

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12 Farouk El-Baz, "Preliminary Observations of Environmental Damage due to Gulf War," *Natural Resources Forum* (New York, 1992) Vol. 16. p. 74.

13 Farouk El-Baz and R.M. Makharita., n. 7, p. 158.

14 Karrar and others, n. 1.

The soil samples collected from different location in the North-Eastern part of Saudi Arabia in March and April by the Saudi Arabia Meteorological and Environmental Protection Agency (MEPA) reports, shows the present of a large amount of Nickel and Vanadium content from distance – metal concentration correlation. It also reported that Kuwait crude oil contains has 10 mg/kg and 30 kg/mg of nickel and vanadium respectively. The present of these heavy metals in the soil reduced aeration and permeability by incrustation. This hindered seed germination leading to crop losses, decreased soil fertility and forest losses.[15]

The soil covered with oil and soot increased nickel and vanadium contamination from the atmospheric fallout.[16] It was believed that the magnitude of contamination with this heavy metal in Kuwait would be much higher because maximum amount of burning of oil wells that produced a huge quantity of smoke and oil spill occurred in Kuwait.

To control further degradation of the desert soil and ground water from oil contamination, the following remediation steps were taken. These include:

1. Filling of empty trenches using the recently mobilized sand to limit the availability of sand size particles to the action of winds.
2. Pumping of oil from the lakes and stored in the tanks for future used or mixing with crude oil.

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[15] Soloni Sakhuja, Surindar Kaur and K.G. Mukerji., "Gulf War and its Impact on Environment," *World Affair* (New Delhi, 1991) Vol. 2-3, p. 45.

[16] Karrar and other, n. 1., p. 55.

3. Removing the oil saturated soil areas covered by oil lakes to limit potential long-term effects on soil acidity or ground water pollution.

4. Replacing the removed soil with clean sand to return the land to the original flat contours.[17]

Threat to Desert Vegetation

There are primarily three types of plant communities found in the desert plains. They are controlled by the soil characteristics as well as rainfall. Cyprus steppes are found in South and Southwest of Kuwait city. Rhanterium steppes are found in the central and extreme northwestern and southern part. Desert vegetation used to be productive despite scanty rainfall. However, this productive and ecological stability of the desert vegetation changed abruptly, when Iraqi invaders sabotage oil wells and deliberately spill oil into the desert.

The burning of oil well not only released huge black smoke into the atmosphere, but also oil droplets continued to fall within 50 km or so of the burning wells. For instance, those persons remaining in the oil company town of Al-Ahmadi on the east of the Al-Maqwa field were constantly coated in a film of grimy oil every time they ventured outside. "Crops, grasses and palm

[17] Kuwait, n. 4, p. 30.

trees were covered with a thick film of oil. This coupled with lack of light caused many plants to whither."

Tony Burgess, a desert ecologist from University of Arizona (Desert Laboratory in Tucson, Arizona), who visited the Gulf in June 1991 for Friends of the Earth (FOE) write that up to 200 kilometres downwind, they would blacken our fingers when we would rub the stems of the grasses. However, in the immediate vicinity of the burning oil fields, "There is a film of oil over everything that blackens plants, soil and the whole landscape." Few plants looked they had survived, but most plants perished in that kind of coating. It was not only soot that had deposited on the plants oil rain was equally responsible. People there who testified that raw oil were falling from the sky.[18] Both these soot and oil rain act as a physical barriers and hence prevents or at least inhabit the gaseous exchange and reduced the rate of photosynthesis, respiration and transpiration. These happened more to plants with underground reproductive organ, like Rhizomes and bulbs. Bruno Schiefer pointed out that oil rain had caused much damage to the natural desert vegetation in Kuwait and cautioned additional harm to the soil and plants, which might be cause by an increased in acidity.

Unlike the desert surface, which has a positive impact from Tarcrete by stabilising dune sands, some plants have already died from the tarcrete sprayed. This has affected the plants considerably. A clear example can be

[18] Bloom and others, n.5, p. 73.

cited from Al Ahmadi, where thick viscous oil residues that covered them killed plants such as cornulaca, leucacantha, Rhantesium and epapporum. The oil inhabits plant growth and productive mechanisms thereby killing them. This effect was further aggravated by mechanical removal of plants. It was because of this reason that plant geneticist Bikram Gill of the Kansas State University sees a danger to ancestral grasses that may hold genes important to cereals like wheat.[19]

[19] Thomas Y. Canby, "After the Storm," *National Geographic* (Washington D.C., 1991) Vol. 186.

Identification and Assessment of the Impact of War Activities on the Flora in Kuwait. Assessment of Damage/Impact

Activities/ factors	Nature of the impact on plants	Direct	Indirect	Temporary	Permanent	Reversible	Irreversible
Oil roots	1. Smoothing, toxic effects	*	–	*	*	–	*
	2. Reduced metabolic activity	*	–	*	*	–	*
Oil slick	1. Ditto, enhance runoff and prevent water permeation	*	–	*	–	*	–
	2. Hinder seed germination	*	–	*	–	*	–
Oil rain	1. Smoothing, change of metabolic activities	*	–	*	–	–	*
	2. Affect plants through affects on soil-water relationship	–	*	*	*	*	–
Cleanup of oil wells	Create severe salination problem leading to disappearance of *glycophytes* and growth of halophy	*	*	–	*	–	*
Fire	Killing	*	–	–	*	–	*
Soot airborne	Change of metabolic activity decrease of productivity and seed production	*	*	*	*	*	*
Pollution	Affect the pollination and fertilization	*					

Table No: 2 Gaafar Karrar and others, A Report prepared for UNEP. *http///www.google.com.UNEPkuwait.* p. 38.

According to Karachi Business Record report stated that the areas of Quetta, Loralai, Chaman, Kachchi, Dhaadar and Sibi in Pakistan had all received soot – laden rain. A report from Pakistan dated April 10, 1991, described how black rain had destroyed wheat crops in Noshero and Nawabshah district. Crop growers reported that they had lost crops valued at

20 million rupees and claimed compensation from the Sindh Government.[20] The plants were starved from sunlight either because of oil coating or from the thick plume covering the sky, which reduced daytime to near darkness.

Smoothening and poisoning through the discharge or gushing of oil in an area around the oil field also uprooted grasses and small plants. Some recovery was expected over a period of time because seeds would survive the oil and germinate when conditions become favorable. However, huge areas in the vicinity of the fires continued to be carpeted by asphalt, killing plant life and associated animals.

Many animals also died from eating oil-coated plants and general environmental malaises. Plants flourished but it becomes unpalatable to grazing animals. The airborne metal pieces that settled on the ground contaminates the soil and vegetation and poisoned the sheep, goats and camels. Animals grazed on this contaminated vegetation accumulates metal and eventually affects human health by entering into the food chain. Kuwaitis agriculture and human existence were also directly threatened by contaminating the ground water. Plants, which received irrigation, were more prosperous and the palm trees, which received irrigation, were fruiting. On the other hand, the trees which are deprived of irrigation become almost dry. The desert shrubs and plants are also severely

[20] Michael McKinnon and Peter Vine., *Tides of War: Eco Disaster in the Gulf* (London, Iammel, 1991) pp. 158-59.

affected and their branches become fragile and easily broken.

To sum up, the petrochemicals or hydrocarbon compound has seriously affected the functional mechanism of the plants internally and externally. It has also affected their abilities to grow and complete the life cycle. A considerable change in the structure of the plant communities was also expected because the life of the desert plants depends on the osmoregulation in their cell tissue. The flow of ions and osmotic control and adjustment were also severely affected by oil pollution.[21]

Desert Mammalian Community

Kuwait is a small and a topographically uniform country. They have not many mammalian species. Only about 30 species are listed; majority of them belong to rodents (nine species) bats (three species) and insectivores (three species). Of the large mammals four are already believed to be extinct in Kuwait (The Asian Cheetah and the dorcas, mountain and Arabian sand gazelles).[22]

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21 Karrar and others, n.1, p. 40.

22 Conservation Monitoring Centre, n. 9, p. 19.

Identification and Assessment of the Impact of War Activities on the Fauna in Kuwait Assessment Damage/ Impact

Activities /and factors	Nature of the impact on animals	Direct	Indirect	Temporary	Permanent	Reversible	Irreversible
Oil soot	Killing of soil invertebrates which cannot escape rapidly	*	*	–	*	–	*
Oil slick	Change of habitat condition closure of burrow	-	*	*	–	*	–
Oil rain	Affect fleece feathers leading to death of animals' movement and flying.	–	*	*	*	–	*
Cleanup of oil wells	Direct killing and change of habit condition	*	*	*	*	–	*
Fire	Killing	*	–	–	*	–	–
Soot airborne pollutant	Affect the feathers, fleece and skin ulcers, appears on the skin of camels and other animals. Some animals died.	*	*	Long period	*	–	* Could lead to death

Table No: 3. Sources: Gaafar Karrar and others, A report prepared for the UNEP *http///www.google.com.unepkuwait*, pp. 43.

The desert mammalian communities were also endangered physically from oil smoothening and tainting. The fallen oil droplet and heavy metal affected the animals physiologically. This happened to animals that habited near the spilling and burning oil wells and to some extent animals

living in area under the shadow of plumes. This can be described in the form of lesions and cancerous growth, caused by contact with the skin or by ingesting certain amounts of petroleum fractions many of which are carcinogenic. For instance, skin ulcers appear on the skin of camels and others animals. Warm-blooded animals are more susceptible to oiling. This caused loss of insulation resulting in lowering of body temperature. Many animals also lost mobility due to oiled desert surface thereby faced starvation and death.

Animals' food and fodder were also seriously affected. Already some fodder plants had died and the others become unpalatable as soot and oil droplets coated it heavily. Moreover, many hydrocarbon particles are carcinogens, which would cause brain damage and cardiovascular disorders[23] to animals. Thus, metal and oil particles deposited on the leaves, grasses and soil threatened the entire ecosystem.

Oil rain and soot also killed many insects when the fleece and feathers come in contact with oil particles. Among the dead insects observed in an oil pool in Al Ahmadi oil field includes:

1. Beatles

- Calosoma Chloroslic tunc (Dej)
- Mesostoma Arabica (Gestro)

[23] Karrar and others, n. 1, p. 58.

- Prionotheca colorata (Oliv)

- Traghyderna parvicallis (Bundi)

- Micipra Arabica (Keszab)

2. Dragon flies

- Hemianay aphiplegars (Burn)

- Selysiothermis higra (Vander Linder)

3. **Unidentified butterflies**

The oil lakes took heavy toll of insects and animals. It swallowed lizards, geckoes, insect and small animals. Bird and small animals, which lived in burrow, were also trapped from oil sprayed and died due to lack of oxygen. UNEP reported the death of some rodent, birds and insect near the blackened oil pools from closed burrow and smothered the desert surface. The decreased of food availability from oil covered the ground surface also contributed to the extinction of many desert animals. Few endangered traditional desert carnivores species like desert cats and fox were equally victims of the war. Small mice and gerbils too were victims as the desert got smothered and died from the effect.

Impact of Cleaning up the Desert

One can easily clean up the language of war-collateral damage, friendly fire, smart bombs, but cleaning up the environmental consequences is a far tougher task.[24] Effort was launched to protect the plant intake, refineries, industrial and the desalination plants. Reintroduction of plants that had gone extinct in the region and non-availability of seed sources in the immediate future posses new challenge. In fact, it would take a considerable amount of effort to reconstruct what potentially had been there before.

In order to avoid another ecological catastrophe, Kuwait used different methods to cleanup the heavily oil infested landscape. The techniques were experimental and needed time for further experiment before moving towards full implementation. However, the remediation of the desert ecosystem was considered important. For this purpose the Government of Kuwait advertised its interest to received offer from competing contractors to removed oil from those pools.

The cleaning up efforts also depends on certain circumstances. Since the lakes were shallow it becomes like tarmac as it did on the beaches. In some area lakes were really deep. In some place it was recoverable and so it was pumped out. Meanwhile, certain amount of volatile compound has

[24] Klaus Taefer., *In defense of the Environment, putting poverty to sword* (Klaus Taefer is an Executive Director of the United Nations Environmental Programme: Nairobi) see detail in http///www.google.com.unepkuwait. Date 15/5/2004.

evaporated. Thus, the grade of oil become less desirable and become harder to work with the solution of recovering.

The cleanup effort was a difficult task to engineers. In some cases, the cleanup efforts do more damage to the desert than just leave them alone. For instances, thousand of trucks, bulldozers, and cranes invaded the desert to reduced the size of oil lakes. These movements led to more compaction of the soil with oil around the oil lakes, uprooting much vegetation, which would either extinct or devoid of vegetation for many decades. Therefore, as a general principal, in many areas they leave it alone rather than sacrifice whatever may be remaining.

In order to get rid off oil from the marshes, they bulldozed down to as much metres below the surface in some region. "Any residual life or any sign of restoration to take place naturally was reduced. The net result was that, the surfaced became cleaner but it was a very different habitat. The change was a fact".

For the cleaning purpose, three prone strategies were adopted. Firstly, the contaminated sand was viewed as toxic waste and the solution found was temporary storage until remediation. This would amounts to gross removal of all the pebbles in the desert, which protect the sand from being blown away by wind. Thus, this has open the way to desert storms, which used to be destructive especially to roads and airports.

Secondly, plowing or harrowing to mix the oil layer with sub-surface soil and sand. It was not known how successful such measures would be.

Thirdly, oil cleanup involved the used of enormous volumes of seawater, which is very high in salinity. Residual effect of the cleanup operation also involved deployment of various kinds of heavy machinery and vehicles. Therefore the soil of the area near the wells was destabilished and subject to compaction and soil erosion. Moreover, the used of seawater for the cleanup process increased the salinity of the soil, which reduced its fertility thereby it became less conducive for agricultural and other vegetative life.

Conclusion

Environment is defined as, "the aggregate of all external conditions and influences affecting the development of an organism". Looking from the prism of this understanding, it clearly gives a picture where life and natural environment are closely knitted and inter-related. Altering or disturbing one part of the ecosystem, as it was seen in the Kuwait desert has immediate and long-term consequences on desert ecosystem. Thus, the environmental fallout from the 1991 Gulf War has affected the whole life system of the desert; in turn the whole ecosystems were affected in varied form and degrees. Effort was made to cleanup the desert environment and to minimised the consequences, which arose from oil well explosion. Yet, the consequences of oil pollution on desert environment would continue to persist for decades if not for centuries.

CHAPTER IV

ROLE OF UNEP IN THE REHABILITATION PROGRAMME

INTRODUCTION

The most formidable challenge before the people of Kuwait, internationals community and the United Nation Organisation when the cease-fire become effective after the Gulf War 1991was the rehabilitation programme. It required an extremely rigorous action plan to put back the thwarted environmental surroundings to normalcy. "Both the oil spill and fire represent precisely the kind of vindictive and wanton destruction that long excluded by the law of war".[1]In response to the destruction, the first and foremost endeavour for the Kuwaitis and the United Nations was to put off the fire. This was successfully achieved by extinguishing the last oil well on November 6, 1991 with great difficulty, as the burning oil fields was surrounded by anti personnel mines.

Though, the economic reconstruction programme of Kuwait, which cost $100 billion, remains important.[2]What was more important at this critical juncture from 'ecocide' was the question of human survival. It seriously threatened the basic needs of life. For instance, volatile toxic chemical compounds in the air/atmosphere, oil rain and soot have made

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[1] Bernard H. Oxman, "Environmental Warfare" *Ocean Development and International Law* (Philadelphia: 1991) Vol.22, p.434.

[2] David Seddon, "The Gulf Crisis: Counting the Cost" *Review of African Political Economy* (New York, 1991) No.51, p.77.

air and vegetation toxic for human consumption. However, what has become more important was the restoration of environmental health by protecting the atmosphere, combating climatic change and global warming, depleting of the ozone layer, and trans-boundary air pollution; protecting the quality of fresh water resource; ocean and coastal areas and resources; protecting land resource by combating desertification; conservation of biological diversity; environmentally sound management of hazardous wastes, toxic chemicals, protection of human health and quality of life, especially, the living and working environment of poor people from degradation of the environment."[3] Identifying the effects arising from burning and spilling of oil and effective plan programme to combat environmental fallout from eco-terrorism was considered important.

United Nation Environmental programme (UNEP) under the auspices of the United Nations Organisation (UNO) General Assembly resolution 47/190 endorsed Agenda 21, decided that UNEP should be the effective coordinator on all environmental issues, setting the Global agenda and promoting its coherent implementation.[4] It was under this resolution the UNEP become the authoritative body of the UN inter-agency in the environmental rehabilitation programme after the Gulf War 1991

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[3] UNEP: *Annual Report 1992.*

[4] *Survey of the Economic and Social Development in the Economic and Social Commission for Western Asia (ESCWA) United Nation* (New York: 1996) p.123.

Role of the UNEP

To carry out the programme, the UNEP urgently set up regional environmental information centres for intensive campaigns to raise public awareness and to encourage people's participation. This was carried out with active collaboration of Kuwait Environmental Protection Council (KEPC).The earliest activity of the UNEP was the sampling and monitoring of the smoke and its pollutant. This was a continuous function in which it has been watchful in case the safe limits of pollutants gases e.g. So_2 exceeded. Secondly, as soon as the massive release of oil into the Persian Gulf was reported on January 1991 UNEP's Regional Office for Western Asia (ROWA) began to monitor all information and data related to the oil slick. The Regional Organisation for Protection of Marine Environment (ROPME) was reactivated with the support of UNEP/ROWA and office was open in Bahrain with the support and encouragement of the ROWA.

The nature of UNEP role in the Kuwait environmental rehabilitation programme was to coordinate various UN inter-agencies. It carried out three fold tasks. Firstly, it carried out the environmental assessment, monitoring, research, information exchange, evaluation and review. Secondly, a body was set up for planning and international consultation. The third was the support measures, which includes environmental law, environmental education, training, information and technical assistance.

UNEP convened three UN inter-agency consultations in Geneva, with a view to intensify cooperation and respond effectively on management of impact of Iraqi aggression on Kuwait. "It was agreed that, there was a need for a comprehensive, well coordinated and integrated approach to mitigate the potential consequences of the conflict on the terrestrial, coastal and the Marine environment, as well as on the atmosphere and the health of the people.[5] It was also agreed that support was needed for the Kuwait action plan.

UN inter-agencies under the overall supervision of the UNEP particularly the World Health Organisation (WHO), United Nations International Children Emergency Fund (UNICEF), United Nations Education Scientific and Cultural Organisation (UNESCO), International Maritime Organisation (IMO), World Meteorological Organisation (WMO), International Atomic Energy Association (IAEA), United Nation Development Programme (UNDP), participated in the UN inter-agencies efforts within its area of competence.

The mission formulated plan of action under the project entitled "Environmental Assessment of the ROPME sub-region and War over Kuwait".[6] ROPME called for a meeting of technical experts which was held in Bahrain in February 26-27, 1991. In that meeting UNEP presented a framework of action to mitigate adverse effects and to

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[5] UNEP: *1991 Annual Report of the Executive* (Nairobi: 1992) p.9.

[6] Gaafar Karrar and others, "A Rapid Assessment of the Impact of the Iraq Kuwait War Inflicted on Terrestrial Ecosystem". A Report Prepared for the UNEP, 1991. *http///UNEP.org.bh/regional.UNEP Kuwait*, March18, 2004.

rehabilitate the environment in the ROPME Region. The action plan was adopted unanimously.[7]

The International Oceanographic Commission (IOC) and UNESCO convened a series of meeting. It was mainly intended to coordinate actions of different international/regional agencies, institutions and individuals' implementation of an Integrated Project Plan (IPP) in the Gulf region. The working group also includes international organisations and agencies that were cooperating with IOC in the studies on the wet component of the UN inter-agency plan of action. The IPP incorporated national plans of the Gulf Countries for combating oil pollution within their territorial boundaries.

A steering committee was set up jointly by IOC and ROPME to take charge of the project. It was conceived to execute the IPP in three phases: immediate, short-term and long-term. The immediate phase was carried out in late February with survey cruise, the R/V Mount Mitchell of the USA, National Oceanic and Atmosphere Administrator (NOAA) with the support and cooperation of IOC and ROPME. The cruise took 100 days for investigating the impact of oil on the shore and near shore areas especially, alone the Saudi Coastline.

The principal objective of the cruise was to collect information on the pollution problem and its effects. These were matters of direct

[7] UNEP: *Biennial Report 1996-97, 27 years UNEP Life on Earth* (Nairobi: 1997)

concern to the decision makers and the general public particularly, the safety of sea food resources and the desalinated water. Other objectives include studies that ensure combating pollution, mitigating its effects and facilitating the rehabilitation efforts. These include:

1. The regional sea water circulation pattern especially, in the north western part and in the vicinity of the Strait of Hormuz, in order to determine the path and dispersion of the pollutions.

2. The qualitative determination of the extent of the oil spill and its effects on key biological habitats and ecosystems such as the inter tidal and sub-tidal muddy sediments, sea-grass beds coral reefs, salt marshes, mangroves and migratory birds.

3. The evaluation of the level of petroleum hydrocarbons and traced metal in the water column, sediment and biota.

4. The study of water stratification pattern in order to determine mixing process.

The long-term study was planned to sustain the environment and evaluate the natural recovery process. It was aimed to serve as a scientific basis developing computer models to predict the behaviour and fate of pollutants in the Gulf and to improve responses to future oil spills. The long-term programme was based on the result of the short-term studies; particularly, identifying the sites that needed extensive work. They visualised core-elements such as:

1. Study of the circulation pattern of the whole gulf. This was used for tracing the track taken by pollutants.

2. Estimation of the residence time to build-up pollutants in water column and bottom sediment in the Gulf.

4. Estimation of the time rate by which the Gulf can get rid of its pollution.

4. To develop an accurate model for water circulation and improved existing oil spill trajectory models for application in future spills.

5. Evaluation of damage and disappearance of sensitive species, injury marks on corals, and sub-lethal stress and their recovery rates.

It was decided that the short-term plan would be implemented over a period of at least twelve months; some elements of the plan might be completed in a shorter time. But 12-months period was the targeted time for the environmental measures.

The long-term plan could last for many years. But for the Gulf rehabilitation programme it was aimed to implement within five-year period.

An activity of the UN inter-agency plan of action and the responsibility organisation/agencies has taken up.

Areas/Activities	Responsibility
(a) **Coastal and Marine Environments:**	
Oil Pollution Response and Clean-up Operations	IMO
Oil Pollution Assessment and Monitoring Water Quality	IOC/IAEA
Oceanographic Observations and Data Support	ROPME/IOC
Coastal/Marine Ecological Assessment	UCN/WWF/IOC/UCN/FAO/10C
Living Marine Resource (Habitat)	UNCHS
Coastal Infrastructure	ROPME/UNEP
Remote Sensing/Data-base Support	
(b) **Atmosphere**	
- Air Quality/Effects on Human Health	WMO/WHO/IAFA
Air/Sea Exchange	IOC
Meteorology and Long Range Air Pollution	WMO

(c) **Terrestrial**

Food, Soil, Agriculture	FAO/IOC
Terrestrial Ecosystem/Desertification	UNEP/ROWA
Food Safety, Drinking Water	WHO
Shelter/Welfare (habitats)	UNCHS/ WHO

(d) **Hazardous Waste Management**

Assessment of Damage to Industrial Sector and Risk of Release of Hazardous Waste	UNIDO/WHO/UNCHS
Industrial Safety	UNEP (IEO) UNIDO

Table: 1

After the formulation of action plan and assignment of responsibilities to various UN inter-agencies, UNEP organised a consultation meeting in Geneva in order to coordinate the work of these agencies and direct their diverse capabilities towards a rapid and efficient response in combating pollution in the Persian Gulf. In the following days a series of meetings of the UN specialised agencies resulted in the development of what is called the UN Inter-Agency Plan Action (UNIAPA) which was also adopted by ROPME. The plan consists of three phases: Survey, assessment and the action plan design. The plan covered

four inter linked area of the coastal and marine environment, atmosphere, terrestrial and hazardous wastes.

Rehabilitation Work

In order to make sure that the ecosystem lived a full life, capable of carrying out the whole biological process without defects, the UNEP and its agencies in rehabilitation programme sought to ensure that the terrorised ecology was receiving adequate and appropriate remedies. Nature of disability, condition, background and likely future life was also identified for proper treatment. Since, rehabilitation and protection programme for the environment is rather wide and diverse; UNEP adopted a broad strategy within the context of the condition in the ROPME Region. The following are the guiding strategy.

1. The cornerstone was regional cooperation and action. The nature and magnitude of problems and the types of solution needed for correcting them and the individual state action to be undertaken to achieve these ends were identified. Pollution of the atmosphere or of fresh or sea water are handy examples.

2. Simplicity and attraction of public support.

3. Easy to execute and easy to maintain.

Priority Areas

In all the meetings held with responsible persons in Kuwait the selection of priority areas were discussed. Quick discussion and early decision methods were adopted by UNEP in dealing with the environmental damage because the cost of repair or rehabilitation may escalate by many folds in few years. On the basis of the discussion held the following issues were identified as priority areas for action within the programme.

1. Public security.

2. Other human, animals and plant life threatening hazards and toxic agent.

3. Rehabilitation of socio-economic development including re-establishment.

4. Long-Term environment schemes including monitoring

5. Recreational areas.

These were identified as priorities of immediate concern to life. Equally important, the project which needed remediation were also identified. They are:

1. Clearance of mines and light munitions.

2. Survey supported land and demarcated dangerous area where travelling camping organizing should be prohibited.

3. Removal of oil from oil pools/lakes.

4. Rehabilitation of research institutes.

5. Rehabilitation of agricultural farms.

6. Establishment of national environmental monitoring and assessment centres.

7. Rehabilitation *Jal Azzor* and other bio-reserve and established additional ones.

8. Rangeland management scheme incorporating.

9. Enforcement of the Amri Decree (1982).

10. Enforcement of utilization of native perennial range. Plant species such as Rhantireum Epapossum, Artemisia Vera Alfa and Haloxylon and Solicornicum.

11. Promote afforestation project.

12. Sand dune fixation programme.

13. Develop recreational centres.

14. Declared uninhabited island as bio-reserves.[8]

UNEP assisted the countries of these regions by raising additional fund for rehabilitation programme. The Secretary-General of the International Maritime Organisation announced the establishment of a special international fund to combat the oil spill in the Persian Gulf. UNEP also approached the oil and petroleum industry to explore cost effective ways to address long-term effects of large oil spills, drawing from experiences.[9]

By mid May 1991 funds were pouring in for environmental mitigation from UN countries. Major contributors were; £ one million from the United Kingdom (UK) government, $1.5 million from the government of Japan; forty million Franc worth of cleaning up equipment and services from the government of Luxembourg. Equipment in kind was also contributed by the government of Germany. In addition, governments of Netherlands and the government of Switzerland have contributed 250,000 Swiss Franc. The Commission of European Communities has also contributed $ 1 million.[10] Over $ 6 million was donated to the IMO for Persian Gulf water clean-up. The amount was only a third of one percent

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8 Karrar, n.6, pp.69-70.

9 UNEP: *Annual Report of the Executive Director, 1993.*

10 Michael McKinnon and Peter Vine, *Tides of War: Eco-Disaster in the Gulf* (London: Immel, 1984) p.128.

of the Exxon Valdez clean-up costs.[11] The USA was not among the twelve nations which contributed money to the IMO.[12]

Besides financial assistance, technical help was also rushed to the region from different countries such as the USA, the European Community, the United Kingdom, France, Germany, Netherlands, Canada, Norway, Japan and Australia. The timely response of the regional and international organisations (ROPME, UNEP, UESCO/IOC, IMO, and WWF etc.) and consultants, providing financial support and training to local personnel, clearly demonstrates the solidarity of the international community during such an environmental crisis.

International Organisation Co-ordination Centre: List of Government Equipment offered and provided

Country	Offered	Provided
Australia	600 Coastal Containment boom 2 skimmers 3 beach cleaning units and 2 Troll 1000 m giant model boom.	2 skimmers
Belgium	6 vehicles and 5 lorries equipped with total 2,582m of harbour boom, 2 skimmers, 2 vacuums tracks, shore cleaning equipment	
Canada	200,000m,coastal/harbour containment boom. 10 skimmers	6000m harbour boom, 5,skimmers, 2 mobile bird cleaning trailers to Bahrain.

[11] F.M. Hawley, *Against the Fire of Hell: The Environmental Disaster in the Gulf* (Orlando: Harcourt Brace Jovanovich, 1992) p.64.

[12] Green International, *The Environmental Legacy of the Gulf* (Washington: Green Peace, 1992).

Denmark	2,000 m open ocean and 1800m coastal containments boom, 2 skimmer, 5 oil trawls unit 3 floating collection containers (100 cu. M each) absorption materials	
Finland	600 m open sea containment boom	
Germany	Multi-purpose vessels with oil recovery systems; 400m open ocean. 1000m coastal and 800m harbour boom, 5 skimmers and	1296m coastal and 1800m harbour containment boom, 4 skimmers, 1 steam cleaning unit and shoreline cleanup equipment and 15 flexible storage tanks to Qatar's
Greece	1,500 as open ocean containment boom	
Japan	30 portable skimmers and 10 skimming 21,000m boats for Saudi Arabia, Qatar and Bahrain.	21,000m harbour containment boom and 6,000m ocean containment boom 40 tonnes of oil absorbent to Saudi Arabia. 10,000m harbour containment boom, 5 tonnes oil absorbent to Qatar 10,000m harbour containment boom and 5 tonnes oil absorbent to Bahrain.
Netherlands	800m open ocean containment 10 skimmers	Equipment for the protection of Abu Ali Island, Saudi Arabia.
New Zealand	432 m oil absorbent booms 2,00m open Ocean containment boom, skimmer and 2 oil mops to Saudi Arabia.	

Poland	2 vessels with oil recovery system 400m Coastal and 1200m of harbour containment booms	
Sweden	500m open Ocean and 1,400m harbour containment boom, 2 skimmers, 1 supply vessel, 1 Tug and shoreline cleanup equipment.	
United Kingdom	Rope mops, 27 storage tanks, 3 beach vehicles, 4 stream cleaners.	1,400m offshore boom. 3,600 m inshore boom. 1000m absorbent boom, 4 skimmers, 4 storage tanks to Saudi Arabia and 6 skimmers to Bahrain To air eye falcon jet aircraft with oil slick detecting radar system to Saudi Arabia.
USSR	2 Multi-purpose vessels with oil recovery system, 1 small tankers 3,100 m open ocean containment booms	

Table No.3 Source. *IMO Gulf Oil Spills information Bulletin No.5, March 13, 1991*

Australia, Canada, French, Germany, Japan, Netherlands, Norway, UK, US and the Commission for European Communities (EEC) also provided pollution experts to the Persian Gulf area.

Course of Rehabilitation

The environmental rehabilitation programme by nature has seen a plethora of activities and inter-related action. The failure of one of them will have a repercussion on several others. A thorough and meticulous follow-up for the smooth and sound progression in the implementation of the programme is essential. In order to avoid further environmental disaster, massive cleanup programme on oiled sea, desert, bird and clearance of land mines was carried out. The first and foremost action taken up was to create public awareness and encourage public participation which was considered vital for any successful programme.

Equally important was the setting up of national Environmental monitoring and assessment centre. This was strongly recommended and accorded high priority in the rehabilitation programme. This was mentioned in the report of the Executive Directors of UNEP to the governing council sessions, in May 1991. With a host of regional task teams, scientists and experts on various aspects of climate change worked together and prepared an overview on the implication of climate change on marine and coastal areas, as well as on socio-economic activities and structure of the region. Monitoring was mainly done to observe how pollution could do damage to the environment and also how to avert possibility of damage, therefore:

1. Monitoring was done persistently on various pollutants produced, as a result of the hostilities. Many of these pollutants in the atmosphere, soil, vegetation and water were named in the relevant report.

2. Special monitoring scheme was taken up to detect genetically or to see any carcinogenic changes in man, animals and plants.

3. Monitoring habitats and improvement action work was carried out on indigenous and migratory birds as well as butterflies.

4. Monitoring pollution dynamic on certain fauna e.g. Scorpion, beetles, rodents and reptiles.[13]

Klaus Taeffer, the Executive Director of the UNEP reported that over 4 million tonnes of soot and sulphur did not climb higher than 5,000 metres. Thus, the potential of damaging regional and possibly global has been averted.[14] However, it affected human health due to emission of burning oil and inhalation of toxic gases which caused respiratory trouble ignited by high concentration of semi-carbon sized particles especially, carbon particles resulting from incomplete combustion. "Death rate in Kuwait has risen by 10 per cent over the following years due to oil related pollution".[15]

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13 Ibid.

14 Klaus Taeffer, "In Defense of the Environmental, Putting, Poverty to the Sword." *http//www.google.com UNEP Kuwait*, April 4, 2004.

15 Ibid.

UNICEF mission dealed with the health and nutritional needs of children in Kuwait. According to statistics released, during 1990-1994 the number of malnutrition cases increased from 102,487 to 1,312, 678 and the number of poliomyelitis because of permanent paralysis cases increased by a factor of 7.5 during 1989-1993. [16] UNICEF child psychologists said, the stress and anxiety generated by the war had caused children trauma. Kuwaiti children are still feeling the psycho-social trauma [17] UNICEF carried out both short and long-term rehabilitation programme to restore children to normal state of mind.[18]

Land mines and other explosive devices also posed a threat to the Kuwaiti population. Injuries from explosive ordinance occurred at the rate of 4 or 5 deaths per day. In March 1991, it was reported that such incident led to the death of more than fifty.

The armed forces of six nations (United States of America United Kingdom, Northern Ireland, Canada, Saudi Arabia and Kuwait) coordinated the search detection and removal operation with the combined Civil Affairs Tasks Force under the Banner of "Camp

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16 WHO, *Reports submitted to the Intercountry Meeting and Development Plan for Community - Based Rehabilitation*, Beirut, 28 November to 1 December 1994.

17 *Economic and Social Commission for West Asia. Survey of Economic and Social Development in the ESCWA Region United Nation* (New York, 1995) p.111.

18 Kuwait: Report to the Secretary-General. *Assessing the Scope and Nature of Damage inflicted on Kuwait's Infrastructures during the Iraqi Occupation of the country.From 2 August 1990 to February 27, 1991* (Nairobi: UN Department of Public Information, 1991) p. 72.

Freedom."[19] The armed forces experienced casualties in the clearance operation.

Teams of such crew were also recruited and trained. Public participation was also sought in gathering information about explosive remnants. Important international and commercial centres were first cleared. For instance, places like runway and aprons of Kuwait International Airport, Shuaiba Harbour and a few length of beach and seafront in Kuwait city are cleared. Despite all efforts to clear up the mines, it became increasingly difficult as the soil movement via wind and water readily obscured many original*p+5Xland mine marks.

Surveys of suspected land, demarcation of dangerous zone to travellers, camping and grazing areas were also assigned to the same field team. The UNEP report claimed, "The military ordinance clearance operation had celebrated the removal of 3,000,000 explosive items".[20] However, in many places there is no guarantee even in the area swept free from explosive devices.

The International Maritime Organization (IMO) was responsible for coordinating the clean up of the oiled sea. The IMO multi-million dollar for protection of disaster fund was effectively mobilised to accelerate the clean-up process in order to restore healthy marine life, protect destination plant and to save two or three section that are

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19. Ibid.
20. Karrar and others, n. 6, p. 62.

important for wild life. For instance, place like Al Musallaniyah Bay which favoured habitat for migrants' wading bird.

The first such project was taken up in Karan. Here, the priority of removing oil was taken up because it was an important beach for turtles. The task around the island was given to a Scottish Company. A total of 14,200 cu.m of Tarmac was removed and buried in the pits of the interior of the Island. This project was completed before the season's first turtles returned to the Island to lay eggs. The second IMO Fund project involved protection of the remaining areas of un-oiled salt-marsh along the Saudi Arabia[21] off the sandy coasts, favourable to turtles for nesting pit.

Gurmah Island, which was heavily impacted by oil, also received attention from the IMO fund project. The Dutch company Tanker cleaning Amsterdam (TCA) was given the task of flushing free floating oil from the island that affected mangroves and natural drainage system. The TCA's task was to clear the oil from the channel. Here, they used skimmer massively in recovery work. The Royal Commission's contractor, "O'Brien Oil Pollution Service," was entrusted with the clean-up process on the shore of Gurmah. Other IMO projects include Identification and stopping oil leaks from oil terminals. A project at Musharabah Bay was to provide protective boom around un-oiled salt

[21] Saul Bloom (ed.) *Hidden Casualties: The Environmental Health and Political Consequences of the Persian Gulf* (London: Earthscan) 1994, p. 129.

marshes and at Musalamiyah Bay. It established a list of sites with a view to evaluate the most appropriate clean-up techniques for salt marshes. IMO report dated April 26, 1991 stated that the primary sources of oil entering the Persian Gulf has been identified at Al-Ahmadi refinery, this leak was stemmed by placing sand bum over the outlet. Damaged tankers had been removed from site.

Arab American Corporation (Aramco), the Royal Commission and MEPA used manning skimmers and vacuum trucks and dumped the recovered oil into inland disposal pit for salvage later. The cumulative effect was impressive: 20,000 to 30,000 barrels a day.[22]

Bird rescue and rehabilitation programme was another important task taken up by the UN inter-agency. In May 1991, UNESCO organized a workshop on bird's rescue and rehabilitation on oiled bird in Bahrain. The intensive programme includes field training, medical and rehabilitative care to the contaminated birds. Fifty technicians from the Gulf States were trained by a highly qualified team of professionals. They worked under USA Bird Rescue and Research Inc. By the end of the workshop, the Trainees acquired the necessary skills to provide the medical care and clean up the oiled birds.

Al Jubail Wildlife Rescue Centre was the hub of activities throughout and after the conflict. The Jubail centre was established and

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[22] Thomas. Y. Canby, "After the Storm", *National Geographic* (New York, 1991) Vol. 180, No.2. p. 25.

facilities were provided by Royal Commission of Jubail and Yanbu, and staffed by the National Commission for Wildlife Conservation and Development (NCWCD), coordinated with the voluntary assistance from international organizations. Saudi Aramco employees and members of the armed forces and local volunteers were also involved.

Following the capture of birds along Saudi Arabia's oiled beaches, birds and other animals were brought to the centre by professional and volunteer collection teams. On arrival they were received at the reception desk where their details were entered into a book and they were allocated a 'patient card'. This was filled with basic details such as date, where it was found and the identification of the animals, together with observation on its general condition. From there, they were entered into a 'waiting area' and were sorted in terms of priorities; oiled birds were first protected from heat loss or overheating, since their features were no longer effective.[23]

Director of the Al Jubail Bird Rehabilitation Centre says, "We have received about 1,200 birds so far". New animals were re-hydrated with mixed water, sugar and salt and reduced the stress.. Then, the birds were placed in a warm, darkened interior of cardboard boxes. They were taken to a quiet area which reduced stress. After the first few hours, birds were brought to the centres generally in the morning and left in the warm

[23] Michael McKinnon and Peter Vine, *Eco-Disaster in the Gulf Tides of War: Eco-Disaster in the Gulf* (London: Immel, 1991) p. 139.

sunshine and returned them back to dark quiet condition, given them a chance to recover from the trauma experience.

The first treatment was with enzyme solution especially formulated product of lactate, designed to restore electrolytic balance combating dehydration. Then the problem of starvation was tackled, gently at first often with liquid food called duphalite, containing essential enzymes minerals and proteins. Gradually over the coming days they were fed with fish by hand at first and later with the birds taken by them. As birds responded to this treatment, they increased their strength despite being still covered in oil. The birds were washed with household detergent mixed with sugar and salt in the first place. However the success rate was very low with this method of washing. A new detergent for washing oiled animal was developed by Royal Society for Prevention of Cruelty to Animals (RSPCA) in UK Fuller's earth; was adopted. In this method, white spirit soaps, dilute detergent and heat detergent, finally mixed all the three detergents of which by some quirk of fate, happened to be green. RSPCA found out that these products were particularly suitable washing birds contaminated with oil.

The RSPCA claimed that this method, when used by its experienced staff, had 60-70 percent success rate and when it was applied by workers it achieved 64 percent success rate.[24] However, not all the patients survived, according to the Assistant Director of the Al Jubail

[24] Ibid.

Bird Rehabilitation Centre. He pointed out, "At first we lost most of the great cormorants, because they were sensitive to stress. In order to reduce stress the Centre used Inderal, a drug that depressed the heart rate. This medication also worked well. One interesting observation; quite a great cormorants were cleaned and released, the birds that were released had a coloured band put on their leg. In November of 1991, a couple of these great cormorants were sighted again along the Saudi Gulf coast. So they obviously survived the cleaning process.

Jubial Wildlife Rescue Centre Records of Animals Received upto April 1 1991

Species	Total received	Dirty	Cleaned	In pool	Released	Dead
Great Cormorant		328	86	25	13	182
Socotra Cormorant	364	71	37	47	92	117
Black necked grebe	224	-	12	12	3	197
Grate crested	120	-	8	-	-	112

crested grebe						
Slender-billed gull	12	3	-	-	4	5
Great black head gull	8	-	-	2	-	6
Herring gull	8	-	-	-	-	8
Caspian Tern	2-	-	-	-	-	2
Grey heson	2	-	-	-	-	2
Reef heron	3	-	-	-	2	1
Lesser saud	2	-	-	-	-	2
Hover clarlend	1	-	-	-	1	-

Redshank	1	-	-	-	-	1
Pin tail	1	-	-	-	1	-
Mailard	1	-	-	-	-	1
Shoveler	1	-	-	-	-	1
Red Fox	1	-	-	-	-	1
Green Truth	2	-	-	-	2	-
Hawksbil	3	-	-	-	2	1
	1084	160	49	86	120	639

Source: *National Commission for Wildlife Conservation and Development, Riyadh, Saudi Arabia.*

However, all is not well. Mike Evans, coordinator of the Important Bird Areas in the Middle East Project, Cambridge U.K. says, rescue centre near Al Jubail was symbolic. It treated only about 1,300 oiled birds. Most of those were cormorants and grebes which tended to wash up along the shoreline, covered in oil, weak and quite easy to catch. They had an overall cleaning and release success rate of 30 percent. It was not amazingly successful, nor in any oiled wildlife cleanup operation. It made no difference at all compared to the vastly greater numbers of oiled

birds out there which could not be caught or which died on the way or out of 'sight'.

Experts were critical of not only rescue and rehabilitation programme, but also on question of assessment and cleanup as well. Farouk El Baz says, the UN inter-agencies arrived at various times without a coordinated effort. The results of their measurement were often contradictory.[25] At the same time, foreign teams visited the coast almost daily to survey the damage and to prescribe cleanup procedures but not action followed and the clean up work was done from a limited number of locations, even which, they did not do very aggressively.

The effort of the UNEP and its inter-agencies were also weakened by infighting between contractors, back biting and suspicion; a lot of money at stake for those who got the major responsibility for the cleanup, and a lot of competition for responsibility. Lots of time was also wasted in UN inter-agencies enmeshed in bureaucratic rivalries.

CONCLUSION

The efforts of the UN inter-agencies in the environmental rehabilitation programme has to be viewed from the point that, they had done a great humanitarian work not only to the people of Kuwait and its surrounding region but to the whole mankind.Undrestandably it is difficult to engineer the cleaning and clearance of sea and land.

[25] Farouk El – Baz, "Preliminary Observation of Environmental Damage due to the Gulf War", *Natural Forum* (New York 1992) vol. 16, p. 72.

Nevertheless, they ventured into such a risky zone compromising their health, life etc, to take care of our fragile planet. Therefore, the UNEP and its inter-agencies endeavours should not be viewed from the prism of luxury and profit making. Rather, it has to be viewed from the angle of a long lasting peace policy by ensuring the environmental security, reducing the threats of life from the evils of war.It is because of this reason that environmental rehabilitation programme is considered important.

CONCLUSIONS

An impact study of the Gulf War1991 on environment is an attempt to present a broad assessment of damage and losses inflicted on Kuwait. The introspection began after the end of the war, i.e. the withdrawal of the Iraqi occupational force. Preceding sections of the present analyses have detailed various constraints. However, the broad study basically shows sabotaging of oil well has caused unprecedented disaster to Kuwait environment and its surroundings. This study provides representative illustration of the nature and scope of the damage inflicted upon the Environment through the act of war.

The most important environmental event in the Gulf region of the post 1991Gulf war severely damages the ecologically fragile region. The relationship between man and nature was temporarily breached. Almost all section of its population or sector of environment and economy were left untouched. Many innocent lives were lost and caused to suffer to countless others. The damage inflicted to nature seems incalculable. Over two-third of the Kuwaiti population were compelled to flee the country. Nearly a million foreign technicians and workers who were the mainstay of the service sector was forced to abandon their jobs and returned to their countries. The oil industry, which was the nerve centre of the economy, lay in shambles, while other vital sectors of the infrastructure were systematically sabotaged and plundered.

After the occupation, basic social services and other public utility infrastructures crumbled and become dysfunction. The awesome dimensions of the damage

inflicted on the country, together with efforts needed to reconstruct the wrecked infrastructure, had imparted a feeling of helplessness and despair. Man and environment faced crisis situation of compelling and competing priorities. Nevertheless, the most visible, and undoubtedly the most significant, of the sector were severely affected by the aggression to the oil industry and environment.

The unprecedented catastrophe of hundreds of burning and gushing oil wells and the consequent pollution of the environment overshadow the damage sustained by the rest of the industry. "In monetary terms the situation represented a daily loss of between $ 40 million and as much as $120 million. However, the damage done to the environment is not measurable. Yet the burning and spilling of oil into Kuwait water and the desert, the smoke it releases into the atmosphere and its impact demonstrated the nature fury.

The roaring of fires had created deep psychological trauma for the Kuwaiti. Smoke from oil fires composed many deadly chemical compound and threatened people who were suffering from asthma and other respiratory diseases. It also increases the risked of other related diseases such as heart and cardiovascular disease, cancer, and many others. It affected vegetative life especially from smoke cloud, which reduced the daytime to near darkness. This has various told and untold consequences on agriculture, plant and marine habitats and created a serious gap in the natural response mechanism. The ecological balance therefore was disturbed by coating the leave and suffocated the plant that seriously threatened animals and human health by entering into the food chain.

The oil-fire problem in Kuwait had also highlighted the need to consider environmental problem in the Gulf on a regional basis. The smoke plumes from the fires had cast the shadow over much other state. Likewise, oil slicks originating in Kuwait moved through the Gulf and affected the waters and coastlines of the neighbouring countries as well. This was one of the reasons why a great emphasis was placed on the regional cooperation in data and information exchange as well as its remedial management actions.

Certainly the more lasting environmental problem facing Kuwait was the desert ecosystem from oil spill, land mines and unexploded ordinance. The 60 million barrels of oil released into the desert formed 246 oil lakes covering a surface 49km; the smoke and soot contaminated 953km of desert; the oil spill soiled 1,500km of the Gulf coast. Since Kuwait is an arid country, where desert vegetations and mammalian species were sparse, oil further threatened their population either in by killing or forced them to migrate to safer areas.

Other challenges posed to the environment and people in Kuwait were the unexploded ordinance and mines. Though, the military unexploded ordinance clearance operation had removed 3,000,000 explosive items. Yet, it did not guarantee the region as mines free zones. It continued to severely mutilate physical body especially arm and feet. This has held backed the Kuwaitis from many activities for fear of hitting land mines.

The humanitarian service provided by countries in the forms of material and financial assistance must be viewed from the point of international concern

and solidarity in times of crisis, to protect and care for our globe from ever increasing fear of global warming. The funds and materials were supervised by UNEP, under the governing body of the United Nation's inter-agencies, though they participated in the rehabilitation activities indirectly. Most of the times they supervised and trained the local people because they knew the local people were better instrument in the field.

Though the ecological disaster was terrible, yet it would be a tragedy if we did not learn from it. Therefore, it makes ecologically wise to convince the gulf countries of the environmental protection. Environmental consciousness will have to be diffused widely among these countries. As it stood, none of the Gulf states were signatory to the International Marine Convention of the Prevention of Pollution from Ships (MARPOL), a convention for regulating and setting standards from oil pollution from vessels. It is an important International Maritime Organisation Conventions. Once the Gulf States signed on and implement MARPOL, which they can well afford to do, it would make a huge difference in caring the nature.

In the ultimate analysis, it can be boldly stated that war, as proved by the 1991 gulf war, is antithetical to our environmental well being. A balanced and harmonious relationship between man and nature calls for total abolition of wars.

BIBLIOGRAPHY

PRIMARY SOURCE

United Nations Development Program: Annual Reports (New York: Oxford University Press, 1992, 1993, 1994).

United Nations Environmental Programmes Report (Nairobi: 1991, 1992, 1993).

Kuwait: Report to the Secretary General on the Scope and the Nature of Damage Inflicted on the Kuwaiti Infrastructure during the Iraqi Occupation (Nairobi: 1991).

World Bank, World Development Report, 1992, Development and the Environment (New York: Oxford University Press, 1992).

UNEP. Register of International Treaties and Other Agreements in the Field of the Environment-1996. United Nation Environmental Programme (Nairobi, 1997).

http:///www.unep.org.bh/regional

http:///www.unep.org.bh/stateof.htm

http:///www.Google.com.unepKuwait

SECONDARY SOURCES

BOOKS

Alan, Richard and Waterbury, John, A Political Economy of the Middle East (Boulder: Westview Press, 1990).

Amnesty International, Iraq/occupied Kuwait: Human Rights Violation Since August 2,1990 (New York: A.I., 1990).

Arkin, William M and Others, On the Impact: Modern Warfare and the Environment: Case study of the Gulf War (New York: Penguin Books, 1991).

Benson, John, Environmental Ethics: An Introduction with Readings (London: Rutledge Taylor and Group, 2000).

Bloom, Saul and Others, Hidden Casualties, the Environmental Health and Political Consequences of the Persian Gulf War (London: Earthscan, 1994).

Bulloch, John, The Gulf War: Its Origins, History, and Consequences (London: Methven, 1989).

Chomsky, Noam, The Gulf Crisis (Cambridge: Mass, 1991).

Chomsky, Noam, New World Order: A Postwar Analysis (Cambridge: Mass, 1991).

Chanchreek, K.L., The Gulf War: Causes and Effect (Delhi: H.K Publishers and Distribution, 1991).

Church, H.W, et al., Potential Impacts of Iraqi Use of Oil as a Defensive Weapon (Albuquerque, New Maxico: Sandia National Laboratories, 1991).

Daeffer, J.W., Oil Spill Respond on the Marine Environment (London: Pergamon Press, 1992).

El-Baz, Farouk and Mkharita, R.M., The Gulf War and the Environment. (Switzerland: Gordon and Breach Science Publishers, 1994).

Greenpeace International. The Environment Legacy of the Gulf War (Washington: Greenpeace, 1991).

Goudie .A., The Human Impact on the Natural Environment (Oxford: Blackwill, 1986).

Gupta, Avijit and Ashel, Muku G., Environment and the Developing World (Singapore: Weley and Sons, 1998).

Hawley, T.M. Against the Fire of Hell: The Environmental Disaster of the Gulf War (New York, San Diego: Harcourt Brace Jovanovich, 1992)

McKinnon, Michael, and Vine, Peter, Tides of War: Eco-disaster in the Gulf (Great Britain: Immel Publication, 1994).

McKinley, Michael, (ed), The Gulf War Critical Perspective (Canberra: Allen and Unwin, 1994).

Middle East Watch, Kuwait's Stolen Incubators. (New York: MEW, 1992).

Negal, Andrew Chal, et.al, Kuwait: From the Reconstruction to Accumulation for Future Generation (Washington D.C.: International Monetary Fund; Occasional Paper).

Noorani, A.G., The Gulf War: Documents and Analyses (Delhi: Konark Publishers, 1991).

North, P. Richard, Life on Modern Planets: A Manifesto for Progress (London: Manchester Press, 1989).

O'blance, Edgar, The Gulf War (London: Brassey's Defence publishers, 1988).

Payoyo, Peter Bautista, Ocean Governance (London: United Nations University Press, 1994).

Plant, Glen, Environmental Protection and the Law of War (New York: Belhaven press, 1992).

Radcliff, M and Berton,T., Social Theory and Environment (London: Routledge, 1994).

Reed, David, ed., Structural Adjustment and the Environment (Boulder: Westview Press, 1992.

Salinger, Pierre and Laurent, Eric. Secret Dossier: The Hidden Agenda Behind the Gulf War (New York: Penguin, 1991).

Schiefer, H.Bruno (ed.) Verifying Obligation Respecting Arms Control and the Environment: A Post War Assessment (Workshop Proceedings for Arms Control and Disarmament, Division External Affairs and International Trade, Canada (University Of Saskatchewan, 1992).

Somerville, Rechard, C.J., Understanding Change (University of California Press, 1996).

Urul, A.D, Philosophy and the Ecological Problem of Civilization (Moscow: USSR Academy of Science. Progress Publisher, 1983).

U.S. Environmental Protection Agency, Kuwait Oil Fires: Inter agency Report (Washington: EPA, 1991).

Winstone, H.V.F. and Freeth, Z., Kuwait: Prospect and Reality (London: George Allen and Unwin Ltd, 1991).

Yant, Martin. Desert Mirage: The True Story of the Gulf War (New York; Prometheus, 1991).

ARTICLES

Aarts, Paul, "Democracy + Oil and the Gulf War," Third World Quarterly (London), Vol.13, No.3, 1992, pp.523-538.

Agwani, M.S., "Battle and Beyond," Mainstream (New Delhi) Vol.29, No.18, 23 February1991, p .5

Amy, Lorie, "Contemporary Travel Narratives and Style Politics: American Women Reporting after the Gulf War," Women Studies International Forum (New York) Vol.2, No.5, Sept-Oct, 1999, p.525-pp. 539.

Aoyama, Teiichi, "The Gulf War and Environmental Destruction," Greenpeace (New York) Vol.13, March 23, 1991.

Brown, Neville, "Blazing Oil Wells of Kuwait," World Today, (London) Vol.47, No.6, Junuary 1991, pp.93-94.

Browning, and others, "Environmental Effects from Burning Oil Wells in Kuwait," Nature (Berlin) May 30, 1991.

Cambay, Thomas.Y, "After the Storm," National Geographic (Washington D.C.) Vol.180, No.2, August 1991, pp.2-35.

Dabla, Bashir Ahmad, "Dimensions and Implication of Demographic Change in the GCC Countries," Development Policy Review (The Hague) Vol.9, No.1, March 1991, pp. 29-36.

Environmental Legacy in Kuwait: An Environmental Assessment of Kuwait.http///: www.gci. /Green Cross Programmed/legacy/Kuwait 7 years html/

Farouk, El-Baz, "Preliminary Observations of Environmental Damage due to the Gulf War," "Natural Forum (New York) Vol.16, 1992, pp.71-75.

Greenwood, Christopher, "Iraq's Invasion of Kuwait: Some Legal Issues," World Today Vol.47, No.3, March 1991, pp.39-42.

Horgan, John, "The Muddled Cleanup in the Persian Gulf," Scientific American (New York) October 1991.

Kanovsky, Elayhn, "Why Oil Crisis Won't Last," Orbis (New York) Vol.35, No.1, Winter 1991, pp.79-92.

Knight, Michael, "Air War Targeting: Sparing the Civilian," World Today, Vol.59, No.4, April 2003, pp.4-6.

Mahami, Riad, G, "Long-term Impact on Arab Nations," Mainstream, Vol.29, No. 18, February 23, 1991, p.8.

Marzouk, M.Sand and Koudan, Mahmud, "Retrospective Evaluation of Environment Protection Projects in Kuwait." Journal of Developing Areas (New York) Vol.23, No.4, July, 1989 .pp: 567-582.

Meyer, Gunter, "Labour Migration into the Gulf and the Impact of the Latest Gulf War, " Applied Geography and development (New York) Vol.39, 1992, pp. 106-125.

Mitchell, Ronald, "International Oil Pollution and Treaty Compliance," International Organization (Cambridge University Press) Vol. 48, No.3, Summer 1991, pp. 425-458.

Mullick, M.A, Hussein., "Iraq-Kuwait Conflict and the Developmental Scenario in the Peninsula Arab Countries, "Pakistan Development Review (Islamabad) Vol.30, No.4, 1991, Winter, pp. 995-1001.

Naidu, K., "Imigrant Lobour in Kuwait," Monthly Commentary (New Delhi) Vol.3, No.4, November 1990, pp. 6-7.

Oxman, Bernard, H., "Environmental Warfare." Ocean development and International Law,"(Philadelphia, 1991) Vol.22, 1991, pp.432-440.

Pathak, Akhileshwar, "State and Environmental Law," International Studies (New Delhi) Vol.30, No.4, October-December 1993, pp. 436 - 474.

Price, A.R.G. "Possible Environmental Threats from the current Gulf War," Greenpeace (Washington) February 2, 1991.

Radnilovic, T, "Gulf Crisis: Causes, Consequences, Actor and Prospects for Solution" 'Review of International Affairs (Belgrade) Vol.41, No. 974, November 5, 1990, pp.23-25.

Raju, K.V., "Gulf Crisis: Hard Time Ahead," Monthly Commentary Vol. 32, No.3, October 1990, pp.14-15.

Rosenberg, R. "Trade and the Environment Economic Development Verses Sustainable Development," Journal of Inter-American Studies and the World Affairs (University of Miami) Vol.36, No.3, Fall. 1994, pp.129- 156.

Saith, Ashwani, "Absorbing External Shocks: The Gulf Crisis; International Immigration Linkages and the Indian Economy," Development and Change (The Hague) Vol.23, No.1, January 1992, pp.101 -146.

Sakhuja, Saloni and others, "Gulf War and its Impact on Environment," World Affairs, January 2, 1991, pp.42-45.

Seddon, David, "Gulf Crisis: Counting the Cost," Review of African Economy (New York) Vol.91, No.51, July 1992, pp. 77-83.

Singh, Rai, "Slim Chance of Averting Gulf Catastrophe," Link (New Delhi) Vol. 33, No. 23, 1 January 1991, pp.8-11.

Small, Richard D., "Environment Impact of Fire in Kuwait," Nature (Berlin) Vol.11-12, March 7, 1991.

Sterner, Michael, "Navigating the Gulf," Foreign Policy (Washington D.C.) Vol. 81, Winter 1990-91, pp.9-52.

Wescoat, James L., "Resources Management: Oil Resources and the Gulf Conflict," Progress in Human Geography (London) Vol.16, No. 2, June 1992, pp.243-256.

Zedalis,Rex., "Burning of the Kuwait oil field and Law of War," Journal of International Law (Nashville) Vol.24, No.4, 1991, pp.711-756.

Appendix
International Law

United Nations General Assembly Resolution 44/224

International co-operation in the monitoring, assessment and anticipation of environmental threats and in assistance in cases of environmental emergencies.

22 December 1989
Adopted without a vote
The General Assembly

Convinced that one of the main global problems facing the world today is the deterioration of the environment,

Aware that increasing environmental degradation caused by human activities has led in some cases to irreversible changes in the environment, which threaten life-sustaining ecosystems and undermine the health, well-being, development prospects and the very survival of life on the planet,

Also aware that potential environmental disasters, whether natural, accidental or caused by human beings, as well as accidents could pose serious and immediate dangers to populations and to the economic development and the environment of the affected countries and regions,

Convinced that through monitoring, assessment, anticipation and prompt multilateral response, if requested—in particular, on the part of the United Nations system—environmental threats could be minimized or even prevented,

Also convinced that early warning of emerging environmental threats and degradation would help Governments to take preventive action,

Noting with appreciation that work undertaken by the United Nations Environment Programme to develop criteria for the identification of environmental threats at the national, regional, and global levels,

Stressing the need for close co-operation between all countries—in particular, through a broad exchange of information, scientific knowledge and experience as well as transfer of technology—in monitoring, assessing and anticipating environmental threats, dealing with environmental emergencies, and rendering timely assistance, at the request of Governments, in accordance with respective national laws, regulations and policies and taking into account the particular needs and requirements of the developing countries,

Affirming the need in this context for closer co-operation between the United Nations Environment Programme, the Office of the United Nations Disaster Relief Co-ordinator, the World Health Organization and the World Meteorological Organization and other competent organs,

tasks, taking into account the needs of the countries concerned, particularly the developing countries;

6. Also requests the Secretary-General to submit the report mentioned above for consideration during the preparatory process for the United Nations Conference on Environment and Development;
7. Invites the Governing Council of the United Nations Environment Programme to consider the report referred to in paragraph 5 above and to present its views thereon to the General Assembly at its forty-sixth session, through the Economic and Social Council.

Excerpts From International Agreements on War and the Environment

Below are relevant sections of the Protocol I Additional to the Geneva Conventions of 1949, done at Berne, June 10, 1977. Both Iraq and the U.S. are signatories.

ARTICLE 35.3

It is prohibited to employ methods or means of warfare which are intended, or may be expected, to cause widespread, long-term and severe damage to the natural environment.

ARTICLE 54.2

It is prohibited to attack, destroy, remove or render useless objects indispensable to the survival of the civilian population, such as foodstuffs, agricultural areas for the production of foodstuffs, crops, livestock, drinking water installations and supplies and irrigation works, for the specific purpose of denying them for their sustenance value to the civilian population or to the adverse Party, whatever the motive, whether in order to starve out civilians, to cause them to move away, or for any other motive.

ARTICLE 55

Section 1: Care shall be taken in warfare to protect the natural environment against widespread, long-term and severe damage. This protection includes a prohibition of the use of methods of warfare which are intended or may be expected to cause such damage to the natural environment and thereby to prejudice the health and survival of the population.

Section 2: Attacks against the natural environment by way of reprisals are prohibited.

programmes and agencies of the United Nations system, bearing in mind the co-ordinating role of the United Nations Environment Programme on environmental matters in the United Nations system,

Taking note of the fact that other proposals have been made on strengthening and improving the effectiveness within the United Nations system of international co-operation in monitoring, assessing and anticipating environmental threats and the rendering of timely assistance in cases of environmental emergencies,

1. Recognizes the need to strengthen international co-operation in monitoring, assessing and anticipating environmental threats and rendering assistance in cases of environmental emergencies;
2. Reaffirms that the United Nations system, through the United Nations General Assembly, owing to its universal character, is the appropriate forum for concerted political action on global environmental problems;
3. Underlines the importance of broader participation in Earthwatch, established by the United Nations Conference on the Human Environment and operated by the United Nations Environment Programme, in order to strengthen its capacity to make authoritative assessments, anticipate environmental degradation and issue early warnings to the international community;
4. Reaffirms that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their environmental policies and also reaffirms their responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction and the need to play their due role in preserving and protecting the global and regional environment in accordance with their capacities and specific responsibilities;
5. Requests the Secretary-General, assisted by the Executive Director of the United Nations Environment Programme, to prepare a report, on the basis of the views of Member States and existing national and international legislation in this field, containing proposals and recommendations on possible ways and means to strengthen the capacity of the United Nations:
   (a) To monitor, assess and anticipate those threats;
   (b) To define criteria for determining when environmental degradation undermines health, well-being, development prospects and the very survival of life on the planet to an extent that international co-operation may be required, if requested;
   (c) To issue early warnings to the international community when such degradation becomes imminent;
   (d) To facilitate intergovernmental co-operation in monitoring, assessing and anticipating environmental threats;
   (e) To assist Governments facing environmental emergencies, at their request;
   (f) To mobilize financial resources and technical co-operation to fulfill the above

ARTICLE 56

(Prohibits attacks against) works or installations containing dangerous forces, namely dams, dikes and nuclear electrical generating stations.

Below are the relevant sections of the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD), done at Geneva, May 18, 1977.

ARTICLE 1

Section 1: (Asks that) each state party to the Convention undertake not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party.

Article 2: (Explains "environmental modification techniques" as referring to) any technique for changing—through the deliberate manipulation of natural processes—the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space.

Abbreviations and Glossary

Abbreviations

AEA	U.K. Atomic Energy Authority
AGU	U.S. American Geophysical Union
ARAC	Atmospheric Release Advisory Capability at LLNL
ARAMCO	Arab American Oil Company
BCCI	Bank of Credit and Commerce International
BNL	Italian Banca Nazionale del Lavoro
CBUs	cluster bomb units
CBWs	chemical and biological weapons
CCC	Commodity Credit Corporation
CCN	cloud condensation nuclei
CEA	French Atomic Energy Commission
CEC	Commission of the European Communities
CIA	U.S. Central Intelligence Agency
CIR	U.S. Department of Commerce Bureau of the Census Center for Investigative Research
C.I.S.	Commonwealth of Independent States (the former U.S.S.R.)
CND	U.K. Campaign for Nuclear Disarmament
CNN	U.S. Cable News Network
CTA	Brazilian Centro Technico Aeronautico
CWC	Chemical Weapons Convention
DNA	U.S. Defense Nuclear Agency
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DSAA	U.S. Defense Security Assistance Agency
DTI	British Department of Trade and Industry
ECGD	Export Credit Guarantee Development
EMIS	electromagnetic isotope separation
ENMOD	Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, United Nations, 1977
EPA	U.S. Environmental Protection Agency
FAE	fuel-air explosives
FAO	UN Food and Agriculture Organization
FBI	U.S. Federal Bureau of Investigation
FDA	U.S. Food and Drug Administration

FOE	Friends of the Earth
GAO	U.S. General Accounting Office
GCC	Gulf Cooperation Council
IAEA	UN International Atomic Energy Agency
IAPGTF	U.S. Interagency Persian Gulf Task Force
ICBP	International Council for Bird Preservation
ICJ	International Court of Justice
ICRC	International Committee of the Red Crescent
ILO	UN International Labor Organization
IMO	UN International Maritime Organization
INC	Iraqi National Congress
IOC	International Oceanographic Commission
IPPNW	International Physicians for the Preservation of Nuclear War
IST	International Study Team
IUCN	International Union for the Conservation of Nature and Natural Resources
LLNL	U.S. Lawrence Livermore National Laboratory
MARPOL	International Marine Convention on the Prevention of Pollution from Ships
MEPA	Saudi Arabian Meteorological and Environmental Protection Agency
MTCR	Missile Technology Control Regime
NAC	U.S. National Advisory Council
NASA	U.S. National Aeronautics and Space Administration
NCAR	U.S. National Center for Atmospheric Research
NCWCD	Saudi Arabian National Commission on Wildlife Conservation and Development
NEPA	U.S. National Environmental Policy Act
NGOs	nongovernmental organizations
NOAA	U.S. National Oceanic and Atmospheric Administration
NPT	Nuclear Non-Proliferation Treaty
NRC	U.S. Nuclear Regulatory Commission
NSC	U.S. National Security Council
NSF	U.S. National Science Foundation
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
OTA	U.S. Office of Technology Assessment
PAHs	polynuclear aromatic hydrocarbons
PICs	products of incomplete combustion
PHS	U.S. Public Health Service
PIO	U.S. Public Information Office
PLO	Palestine Liberation Organization
RCC	Iraqi Revolutionary Command Council

ROPME	Regional Organization for the Protection of the Marine Environment
SEPP	Iraqi State Enterprise for Pesticide Production
SIPRI	Stockholm International Peace Research Institute
SLAR	side-looking aerial radar
SOTI	Iraqi State Organization for Technical Industry
U.A.E.	United Arab Emirates
UN	United Nations
UNDP	UN Development Programme
UNDRO	Office of the UN Disaster Relief Co-ordinator
UNEP	UN Environment Programme
UNESCO	UN Educational, Scientific and Cultural Organization
UNHCR	UN High Commission for Refugees
UNICEF	UN Children's Fund (formerly the UN International Children's Emergency Fund)
UNIKOM	UN Iraq-Kuwait Observation Mission
UNSCOM	UN Special Commission (for the destruction of Iraq's biological and chemical warfare and missile capabilities)
URENCO	European Uranium Enrichment Consortium
USDA	U.S. Department of Agriculture
WCMC	World Conservation Monitoring Centre
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wide Fund for Nature

Glossary

ACID RAIN	Rain with a pH below 5.6, often due to presence of sulfuric and nitric acids.
ACUTE	Severe but of short duration, as opposed to chronic.
AEROSOL	Particulate and liquid droplets suspended in the atmosphere.
ALBEDO	Fraction of the radiation striking a surface that is reflected—corresponds to color within the visible spectrum.
AMPHISBAENIANS	Tropical lizards of the genus *Amphisbaena.*
ANFAL	The Iraqi government's name for its military program against 4,000 Kurdish towns and villages in late 1980s.
ANTHRAX	Disease of animals and humans caused by the spore-forming bacterium *Bacillus anthracis.*

ARTESIAN WELL	A well tapping groundwater that lies in an aquifer or permeable bed of rock between zones of impermeable rock. Hydrostatic pressure causes the water to rise to ground level.
ARTHROPODS	Class of jointed invertebrates that includes crustaceans and insects.
AUTONOMY ACCORDS	1970 law passed by the Iraqi government granting a small level of autonomy to the three Iraqi governorates with a mainly Kurdish population.
BAATHISM	Political philosophy of the Arab Baath Socialist Party, units of which are in power in Iraq and Syria. A pan-Arabist movement opposed to imperialism, Zionism and Marxism.
BALLISTIC MISSILES	Long-range missiles guided for part of their flight, but becoming free-falling objects as they approach their targets.
BARRAGE	An artificial obstruction in a water course to increase the depth of the water and facilitate irrigation.
BENIGN	Not threatening to health.
BENTHIC	Sea-bottom dwelling (used to describe plants and animals.)
BERM	A long low mound or dike, either human-made or the result of wave action on a beach.
BIOASSAY	Evaluation of the effects of a substance by use of experimental animals.
BIODEGRADE	To decompose under microbial action.
BIOMASS	Mass of biological material.
BIOREMEDIATION	Restoring the environment through the addition of bacteria.
BIOTYPE	A group of organisms sharing a specified part of their genetic make-up.
BLISTERING AGENTS	Chemicals such as mustard gas that attack tissue cells.
BLOOD GASES	Gases such as hydrogen cyanide that interrupt cellular respiration.
BLOOM	Sudden increase in population density.
BOTULISM	Food poisoning caused by the botulinum toxin, causing intestinal and nervous disorders.
CALUTRON	California University magnetron, a machine for magnetically separating U-235 from U-238 isotopes of uranium.
CARCINOGENIC	Cancer-causing.
CATALYST	A substance that influences the speed of a chemical reaction and can be recovered unchanged at the end of the reaction.
CENTRIFUGE	Machine that uses centrifugal force to separate particles of different density.

CHELONIANS	Animals belonging to the order *Chelonia*, comprising the turtles.
CHOLERA	Intestinal diseases caused by *vibrio cholerae*, characterized by violent diarrhea, vomiting and muscular cramps.
CHRONIC	Lasting a long time or recurring often, as opposed to acute.
CLIMATOLOGY	The science dealing with climatic phenomena.
CLOSTRIDIUM	Any of a large genus of spore-forming bacteria, including those causing tetanus and botulism.
CLOUD CONDENSATION NUCLEI	Tiny solid and liquid particles on which water vapor condenses.
COAGULANT	Chemical that turns a liquid into a soft, semisolid mass.
COCCIDIOIDOMYCOSIS	An infectious disease caused by breathing in spores of *Coccidioides immutis*. Early symptoms resemble those of the common cold or influenza—later problems are fever, appetite and weight loss, bluish skin, breathing difficulty and arthritic pain.
COLIFORM BACTERIA	Aerobic bacteria usually found in the human colon.
COMPUTER-NUMERICALLY-CONTROLLED MACHINES	General term for automated manufacturing equipment reliant on computer techniques.
CONVECTION	Atmospheric circulation due to rising of warmer air and sinking of cooler air.
CORAL	Colonies of marine polyps of the class *Anthozoa* that deposit a hard skeleton, forming reefs, usually in tropical seas.
CYCLONE	Weather system characterized by relatively low air pressure compared with surrounding air, violent winds and torrential rain.
DEMOGRAPHY	The statistical science dealing with the distribution, density and other characteristics of human populations.
DENGUE	An infectious fever characterized by severe pains in the joints and muscles.
DEPLETED URANIUM	U-238, the less radioactive isotope separated from U-235 during the process of enriching uranium for nuclear weapons and reactors.
DESALINIZATION	The making of fresh water from salt water.
DESERTIFICATION	The destruction or degradation of vegetation in arid and semi-arid areas.
DILMUN	Sumerian name of an ancient independent kingdom that flourished around Bahrain around 2000 B.C., trading with Sumeria and Babylon.

ENDANGERED SPECIES	According to the *IUCN Red Data Book*, applies to a species unable to reproduce in numbers sufficient to ensure survival, and therefore likely to become extinct if present trends continue.
ENDEMIC	Restricted to a given locality.
EPIDEMIOLOGY	The study of the spread of disease.
ESCARPMENT	Steep slope or cliff.
ESTUARY	The area where a river's current meets the sea's tide.
EUTROPHIC	Ecological condition of a lake characterized by an over-abundant accumulation of nutrients.
FALLOUT	The raining out of particles lifted into the atmosphere after an explosion or fire.
FISSIONABLE	Consisting of atoms that can be split to release large amounts of energy.
GANGRENE	The local death of soft tissues due to lack of blood supply.
GASTROENTERITIS	Inflammation of the stomach and intestine, usually of toxic origin.
GASTROINTESTINAL	Pertaining to stomach and intestine.
GENOTOXIC	Capable of damaging genetic material.
GLOBAL WARMING	Climate change in the form of increasing average temperatures due to human-caused input of carbon dioxide, ozone, methane, chlorofluorocarbons and other gases that enhance the greenhouse effect.
GREENHOUSE EFFECT	The process by which solar radiation is trapped by gases and particles in the atmosphere and warms the planet.
GROUNDWATER	Underground water that saturates the upper portions of the Earth's crust.
GULF	Area of water reaching inland larger than a bay.
GYPSUM	Widely distributed mineral containing hydrous calcium sulfate ($CaSO_4.2H_2O$).
HADLEY CELL	Air circulation in tropical and subtropical latitudes whereby air rises over the equator and sinks around 30° N and 30° S.
HAGUE CONVENTIONS	A series of international treaties on the conduct of war passed between 1899 and 1907.
HEPATITIS	Generic name for diseases that affect the liver—Hepatitis A is caused by a virus, while other forms of hepatitis are caused by parasitical infections and drug abuse. Symptoms may include vomiting, fever and joint pain.
HYDROGEOLOGY	The branch of geology concerned with the occurrence of surface water and groundwater and the function of water in erosion and deposition.

HYDROPHILIC	Attracting water.
HYDROPHOBIC	Repelling water.
HYGROSCOPIC	Attracting moisture from the air.
HYPOTHERMIA	Abnormal lowering of body temperature generally caused by exposure.
INFLUENZA	An acute, contagious epidemic disease, caused by a virus, mainly affecting the upper respiratory tract.
INVERSION	A weather anomaly where the temperature increases with altitude, trapping the air below.
JET STREAMS	Any of several long, narrow high-speed winds floating in a generally horizontal zone in the stratosphere, tropopause and upper troposphere.
KARST	An area of limestone formations characterized by sinks, ravines and underground streams.
KELLOGG-BRIAND PACT	A multilateral agreement attempting to outlaw war and agreeing to peaceful means of settling international disputes, originally signed by 15 nations in 1928, later joined by 49 others.
LANDSAT	U.S. satellite gathering and transmitting data about Earth's natural resources and topography.
LEISHMANIASIS	Infection with protozoa of the genus *Leishmania*, affecting either the inner organs or skin tissues. Symptoms include chronic fatigue, joint pain, diarrhea, gastrointestinal complaints, coughs and fevers.
MAGNETRON	Machine that generates high frequencies and short bursts of very high power by use of electric and magnetic fields.
MANGROVES	Shrubs and trees that grow in thickets and low forests along tidal estuaries, salt marshes and coastal mud flats throughout the tropics, forming diverse local ecosystems.
MARAGING STEEL	Very strong nickel-iron alloys.
MICROPARTICLES	Microscopic particles.
MONSOON	Any wind showing a seasonal reversal in direction—and, in particular, a wind in various latitudes in the Indian Ocean and southern Asia which blows from the southwest from late April to mid-October and from the northeast for the rest of the year. On the Indian subcontinent, the season of the southwest monsoon, a season of heavy rainfall, is called the monsoon season.
MOUSSE	Frothy mixture of oil and water that may eventually weather into tar balls.

MUD FLAT	Muddy land flooded at high tide and uncovered at low tide.
MUTAGENIC	Capable of inducing random genetic change.
NAPHTHA	A product of the fractional distillation of petroleum, the fraction that boils between gasoline and kerosene.
NECROSIS	The sum total of irreversible structural alterations leading to the loss of vitality of a cellular group in a living organism.
NERVE AGENTS	A group of chemicals which induce body spasms and death by asphyxiation, by inhibiting the production of the enzyme acetylcholinesterase, which allows the muscles to relax after contraction.
NUCLEAR WINTER	Hypothetical scenario following nuclear war, in which dust and smoke obscure sunlight and there are abnormally low temperatures and strong winds.
NUCLEATION	The process of forming into or around a nucleus, as when water droplets form around particulate.
OCEANOGRAPHY	Study of the oceanic environment.
OROGRAPHIC LIFTING	The lofting of an air current caused by its passage up and over mountains.
PALEOLITHIC	The period from 2,000,000–10,000 B.C., when humans were hunter-gatherers and used primitive tools including flints for fire.
PANDEMIC	Epidemic over a large region.
PELAGIC	Applies to living things that feed near the sea surface.
PERENNIAL	Producing flowers and seed from the same root structure each year.
PETROCHEMICALS	Chemicals derived from crude oil.
PHYTOPLANKTON	Plankton consisting of plants, such as algae.
PLANKTON	Microscopic organisms found on the sea surface.
PLAYA	Barren depression or low portion of desert region that collects sediments during intermittent cloudbursts.
PNEUMONIA	Disease of the lungs, mostly caused by microorganisms but sometimes having a chemical or physical source.
POLYCHAETES	The largest and only non-hermaphrodite group of the phylum of annelid worms. It consists almost exclusively of sea-dwelling species—polychaete species can be found in almost every ocean habitat.
POLYNUCLEAR AROMATIC HYDROCARBONS	Naturally occurring compounds composed of condensed benzene (C_6H_6) rings, many of them carcinogenic.
PRESSURE	Force per unit area.

Q FEVER	Infection of cattle, sheep and goats which affects mainly the lungs. Symptoms are headache, chills, fever, muscle pain, and malaise.
RADIOLOGICAL WEAPONS	Bombs, such as neutron bombs, that disperse radioactive materials or ionizing radiation with the objective of killing humans and animals and/or contaminating the environment.
RADIONUCLIDE	Radioactive nuclide, a nuclide being a specific kind of atom characterized by the constitution of the nucleus.
RAMSAR SITE	Wetland site protected under the Ramsar Convention signed in Iran in 1971. Signatories to the treaty agree to designate at least one wetland which they will protect or replace with one of equal value if the listed site is destroyed.
RARE	According to the *IUCN Red Data Book*, applicable to a species at risk because of a small total world population.
REM	Unit of ionizing radiation that will produce a biological effect equal to one roentgen of gamma ray radiation.
RICKETS	Disease of the skeletal system, chiefly of children, caused by vitamin D deficiency.
RIFT VALLEY FEVER	Disease transmitted to humans from goats, sheep and cattle. Characterized by fever, muscle pain and headaches, sometimes gastrointestinal hemorrhage and loss of central vision.
RUNOFF	Outflow of rainwater toward rivers along ground surface and underground.
SALT MARSH	Grassland over which salt water flows at intervals.
SAVANNA	Plain or grassland with scattered trees.
SEPTICEMIA	Generalized infection with pus-forming microorganisms.
SHEEN	A thin, shiny coating of oil.
SHIITE ISLAM	The branch of Islam that asserts the legitimacy of the authority of the descendants of Ali, the fourth caliph and Muhammad's son-in-law.
SHOREBIRDS	Birds of the order *Charadriiformes*, including dunlins, plovers, snipes and sandpipers, that are especially adapted to coastal and marsh habitats.
SLANT DRILLING	Drilling for oil diagonally.
SOLVENTS	Chemicals used to dissolve other chemicals.
SPAWNING	Reproduction and the bringing forth of young in fish.
SPECTROSCOPY	A set of techniques for the analysis and interpretation of the electromagnetic radiations emitted and absorbed by matter.

STRATOSPHERE	Layer of the atmosphere extending upward from the tropopause in which the temperature generally increases with altitude, also the primary site of ozone formation.
SUBTROPICAL	Between 15° N and 35° N or between 15° S and 35° S.
SUBTROPICAL JET STREAM	A zone of unusually strong winds situated between the tropical tropopause and the midlatitude tropopause.
SUNNI ISLAM	The majority branch of Islam recognizing the first four caliphs and their successors-in-office as Muhammad's legitimate successors.
SYNERGISTIC	Pertaining to the simultaneous action of separate agencies which have greater total effect than the sum of their individual effects.
SYNOPTIC-SCALE WEATHER	Weather phenomena operating at the continental or oceanic spatial scale, including migrating high pressure systems, air masses and fronts.
SYSTEMIC	Pertaining to a system or to the body as a whole.
TAXA	Biological categories such as species or family.
TEAR GAS	Volatile gas causing eye irritation and temporary blindness.
TIME SERIES ANALYSIS	Extrapolation from a frequency distribution in which time is the independent variable.
TOXEMIA	Pathological condition characterized by toxins present in the blood.
TOXIN	Any biological substance containing or producing poison.
TRAUMA	Any injury caused by the application of external violence, applying to both physical and psychological injuries.
TROPOPAUSE	Boundary zone between the troposphere and the stratosphere.
TROPOSPHERE	Lowermost zone of the earth's atmosphere in which temperature decreases fairly regularly with altitude. The height of the troposphere varies over the polar, mid-latitude and tropical regions from about nine to sixteen kilometers above sea level.
TULAREMIA	Infectious disease of man and animals caused by *Pasteurella tularensis*, marked by conventional signs of toxemia.
TYPHOID	Acute infectious disease caused by the bacillus *Salmonella typhi*, characterized by fever, diarrhea, physical exhaustion and apathy.
VASCULAR PLANTS	Plants containing the specialized food and water conducting cells xylem and phloem. These include all flowering plants, conifers and ferns.
WADI	The channel for a stream that is dry except during periods of rain.

YELLOWCAKE — A uranium concentrate obtained by the extraction of uranium from ores.

ZONATION — Distribution of kinds of organisms in biogeographic zones.