

# Depleted Uranium Radioactive Contamination In Iraq: An Overview

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## Abstract

Depleted Uranium (DU) weaponry has been used against Iraq for the first time in the history of recent wars. The magnitude of the complications and damage related to the use of such radioactive and toxic weapons on the environment and the human population mostly results from the intended concealment, denial and misleading information released by the Pentagon about the quantities, characteristics and the area's in Iraq, in which these weapons have been used.

Revelation of information regarding what is called the Gulf War Syndrome among exposed American veterans helped Iraqi researchers and Medical Doctors to understand the nature of the effect of these weapons, and the means required to investigate further into this issue.

The synergetic impact on health due to the post Gulf War I economical sanctions and DU related radioactive contamination raised the number of casualties in contaminated areas as in southern Iraq.

Continual usage of DU after Gulf War I on other Iraqi territories through the illegal No-Fly Zones and the major DU loaded Cruise Missiles attack of year 1998, all contributed in making the problem increasingly complex.

During 2003, military operations conducted in Iraq by the invading forces used additional rounds of DU in heavily populated areas such as Baghdad, Samawa and other provinces. It is only fair to conclude that the environment in Iraq and its population have been exposed continuously to DU weaponry or its contaminating remains, since 1991.

Accordingly millions of Iraqi's have received higher doses of radioactivity than ordinary background levels. As a result a multi-fold increase of low level radiation exposure related diseases have been registered since 1995. An increase of children's leukemia, congenital malformations, breast cancer etc...

The shift of leukemia incidence rates towards younger children during the recent years, and its association with geographically distributed contaminated areas, offers strong evidence of the correlation between LLR exposure and resulted health damages.

Through this paper, an overview of major scientific DU conclusions will be presented, drawn from investigations and research conducted since the year 1991 by Iraqi researchers and

MDs. Schemes of these researches can be classified into three categories:

1. DU contamination detection and exploration programs.
2. DU effects on human body cells.
3. DU related epidemiological studies.

## **Complete Article**

### **1.0 Introduction:**

Depleted Uranium (DU) weaponry has been used against Iraq since the Gulf War 1 in 1991. Estimated (DU) expenditure of 320 - 800 tons were mainly shot on the withdrawing Iraqi troops from Kuwait to the north of Basrah City.

The use of (DU) ammunition and bombs on Iraqi territory never stopped since 1991. Different generations of (DU) supported Tomahawk missiles & Bunker Buster Bombs [3] have been used during the 90's on what were known as the No Fly Zones (Northern & Southern regions of Iraq), and the 1998 attack on Iraq.

With the comprehensive sanctions that were imposed on Iraq, the USA & its allies purposely used these radioactive & toxic weapons to exhaust Iraq's strength & population to prepare for the invasion of Iraq in 2003. Hundreds of tons of (DU) expenditure were also used during the invasion of Iraq. This was done to worsen the radioactive contamination impact. Additionally, the occupying forces have forbade any kind of (DU) related exploration programs or research [2]. They have also covered up and denied DU's damaging health effects, and refused to release information on the amounts, types and locations of these weapons within Iraq. As a consequence, thousands of Iraqi children and their families are suffering from different low level radiation (LLR) related diseases such as congenital malformations, malignancies, congenital heart diseases, chromosomal aberration and multiple malformations. Women in the contaminated areas suffered high rates of miscarriages and sterility [3].

Pressure from anti-DU groups and the international community due to the effects of the Gulf War Syndrome (GWS) on Gulf War veterans, helped Iraqi researchers start a series of investigation programs on the contaminated areas to estimate the radiation dose the people in southern Iraq and the Iraqi troops were exposed to during military engagements in 1991, and assess the level of contamination in the surrounding environment.

The American administration still claims that the biological and chemical agents of hydrocarbon smoke of oil field fires in southern Iraq are the main causes behind the (GWS) and not the exposure to the DU [2][4]. This is very false and misleading information.

The previously published data of the types and amounts of the chemical fumes and hydrocarbons that were released to Iraq's environment in each Iraqi city due to the 1991 air raids and bombing [5] [6] proves that the areas of Ta'meem, and Salahiddin were the most polluted cities due to the destruction of mines and huge material and armed forces industries. This resulted in the formation of SO<sub>x</sub>, NO<sub>x</sub>, and CO<sub>x</sub> plumes and hydrocarbon smoke clouds. In addition to the pollution that resulted from the burning of thousands of rubber tires used to mislead Tomahawk missiles off their targets (Table 1).

Registered cancer cases, congenital malformations and other related diseases are less in these cities than in Basrah [7], which proves that the major cause of the multifold increase of such diseases in the south was the extensive use of DU weapons in 1991 and the following years.

**Table 1: Contaminants Released to the Environment During the Gulf War of 1991 [5]**

**City**

**Air Pollution burning of**

**Water pollution, release of**

**Soil Pollution**

**Baghdad**

224,000 m<sup>3</sup> of Hydrocarbons burning and crude oils

Soot of burning 2000 rubber tires

300 m<sup>3</sup>/hr sewage released to soil and Tigris river

Underground storage fuel tanks rupture and leaks

**Ninevah**

551 m<sup>3</sup> of gas oil

167 m<sup>3</sup> gasoline and kerosene

300 liters of HCl

835 Kg of Sodium Hypochlorites

1150 rubber tire burning

Release of 1000 m<sup>3</sup> of gas oils to surface water

41,457 liters of gas oil to soil

**Sulaimania**

No record

40 liters of transformer oils

250 m<sup>3</sup> of oil

**Ta'meem**

4,681,000 m<sup>3</sup> of crude oil

910 m<sup>3</sup> gas oil

285 m<sup>3</sup> naphtha

20 × 106 m<sup>3</sup> H<sub>2</sub>S gas

200 m<sup>3</sup> liquid gas

50 m<sup>3</sup> gasoline

4000 burning of rubber tires

No records

60 m<sup>3</sup> engine oils

50 l of conc. Acid H<sub>2</sub>SO<sub>4</sub>

53,674,000 m<sup>3</sup> crude oil

### **Saladdin**

6,228,000 m<sup>3</sup> of light fuel

8,250,000 m<sup>3</sup> of naphtha

288,000 m<sup>3</sup> of heavy oils (hydrocarbons)

13,000 m<sup>3</sup> turbine

10 m<sup>3</sup> engine oil

20 m<sup>3</sup> transformers oils

200 tons of ammonium hydroxides

sewage

10 m<sup>3</sup> of oils

### **Anbar**

3,188,000 m<sup>3</sup> heavy oils

235,910 m<sup>3</sup> of liquefied gas

18,000 tons of raw sulfur

53,600 tons of liquid sulfur

No records

223,000 m<sup>3</sup> crude oils

100 m<sup>3</sup> kerosene

5,616 tons of H<sub>2</sub>SO<sub>4</sub>

180 tons of other acids

### **Najaf**

1,250,000 m<sup>3</sup> of gas oil

No records

3000 m<sup>3</sup> of gas oil

3000 m<sup>3</sup> of turbine oils

### **Babylon**

150 m<sup>3</sup> of heavy oils

35 m<sup>3</sup> of turbine oils

240,000 m<sup>3</sup> gas oils

30,000 m<sup>3</sup> oils

No records

250,000 m<sup>3</sup> gas oils

### **Karabala**

36,000 m<sup>3</sup> heavy oils

No records

No records

### **Wassit**

2000 m<sup>3</sup> kerosene

11,000 m<sup>3</sup> gasoline

11,000 m<sup>3</sup> crude oils

No records

No records

### **Maissan**

23,000 rubber tires burning

Plastic and rubber pipes

No records

1000 m<sup>3</sup> fuel oil pesticides

### **Qadisiya**

86,240 m<sup>3</sup> of oils

36,729 rubber tires and pipes

No records

No records

### **Thi Qar**

1000 m<sup>3</sup> gasoline

No records

10 tons of garbage

### **Muthana**

No records

No records

4 kg of cyanide

### **Basrah**

7,032,000 m<sup>3</sup> heavy naphtha

84,824 m<sup>3</sup> gasoline

20,000 m<sup>3</sup> heavy oils

547 m<sup>3</sup> solvents

28,000 m<sup>3</sup> natural gas

3.4 million barrels of crude oil from carriers

17,000 m<sup>3</sup> crude oil

60 m<sup>3</sup> kerosene

76 m<sup>3</sup> transformers oil

50 m<sup>3</sup> turbines oil

15,000 tons sodium hydroxide

40,000 barrels crude oil

1.314 million barrels of crude oil

The American and British occupation forces are totally responsible for:

- 1- Forbidding any release of statistics related to civilian casualties after the occupation [8].
- 2- Refusal to clean up contaminated areas [9].
- 3- Depriving international agencies and Iraqi researchers the right to conduct full (DU) related exploration programs by USA occupation forces [2] to prevent further damages is the best evidence that these forces are covering up their certain conclusive evidence of the harmful health impacts of DU.

All these acts are crimes against humanity because these weapons are causing undifferentiated harm and suffering to civilians in all contaminated areas. Health effects can range from fatigue and muscular pain to genetic disorder, chromosome aberrations, and malignancies. Existence of DU in the environment will maintain continuous exposure to both toxic and radioactive effects which represent continuous systematic attacks on civilians in an armed conflict (Article 4 of the official regulations and article 7 of ICC).

In this paper the genuine scientific efforts of the Iraqi scientists and researchers who tried hard to define and prove the (DU) contaminated areas in southern Iraq and its health consequences will be reviewed.

Most of these researches couldn't find their way to international peer-reviewed journals because of the comprehensive sanctions imposed on Iraq, even though they have been published in Iraqi universities scientific peer-reviewed journals.

We feel obligated to let the world know that some of these researches cost the authors their lives e.g. Dr. Alim Abdul Hameed Yacoub who was killed, along with his son, when his car was forced off the highway on the way to his home town of Basrah after being attacked twice at his home by pro-occupation militias two weeks before his death. They cost other researchers their freedom, such as Dr. Huda Ammash who was accused of being (Lady Anthrax) and imprisoned without any real accusation for 3 years.

The assassination of 250 Iraqi scientists after Iraq's invasion by occupation militias is the best way not to continue any kind of research including DU-related research [12] in occupied Iraq.

## **2.0 Schemes of DU related research that have been conducted and published in Iraq (1991-2003):**

We can classify research and studies that have been conducted by Iraqi researchers into the following schemes:

## **2.1 Detection and modeling of DU contamination through site measurements and laboratory tests.**

In 1993 the first Iraqi team of researchers from the Iraqi Atomic Commission and the science college of Baghdad University [7] [13] investigated the increase of DU related radioactivity in selected areas west of Al-Basrah where destroyed tanks and vehicles with DU ammunition were still laying around. The areas were: Northern Rumaila oil fields, Al-Shamia, Kharanje, Rumaila and Jabal Sanam. Exposure measurements revealed the existence of DU contamination in the studied areas. Tables 1, 2, and 3 show the results of these measurements.

### **Table (2) Field Measurements at North Rumaila Area [7]**

#### **Type of Chose Sample**

#### **Background**

#### **Chosen Sample**

**1**

#### **Armoured Personnel Carrier BMB-1**

**8.1**

**24.6**

**2**

#### **Armoured Personnel Carrier MTLB**

**8.2**

**9.7**

**3**

#### **T-72 Tank**

**8.7**

**15.1**

**4**

#### **Rescue Tank**

**7.2**

**13.2**

### **Table (3) Field Measurements at Shamia Airfield /Gudairat al-Audhaimi Area [7]**

#### **Type of Chose Sample**



**Background**

**Chosen Sample**

**1**

**T-72 Tank**

**7.0**

**60.8**

**2**

**Armoured Personnel Carrier (Watercan)**

**7.2**

**60.3**

**3**

**Far away area from chosen sample (1)/ T-72**

**7.1**

**7.3**

**4**

**Far away area from chosen sample (2)/ Watercan**

**7.3**

**7.2**

**Table (4) Field Measurements at DMZ and Surrounding Area [7]**

**Type of Chose Sample**

**Background**

**Chosen Sample**

**1**

**Unexploded DU Warhead (near Karrange Oil Pumping Station on the Iraqi-Saudi border)**

**7.4**

**83**

2

**Tank/T-55 (between crossroads Nos. 13 and 14)**

7.6

21

3

**Tank/T-72 (No. 16107)**

7.2

23

4

**Tank/T-55 (left of crossroads No. 9)**

7.4

67

5

**Tank/T-72 (near international observation post between crossroads Nos. 12 and 13)**

7.6

69

6

**Tank/T-72 (south west on Mount Sanam)**

7.0

65

\* Exposure measurements (Micro Roentgen/hr)

In 1996 Al-Azzawi and her team conducted a comprehensive exploration program through the Environmental Engineering Department in Baghdad University [14], [15], [16], [17], [18], [19] (Al-Azzawi et al). The program involved taking hundreds of exposure measurements, soil samples, surface waterway channels, sediments and bio-samples from vegetation cover, fish and grazing animal tissues from areas of heavy military engagement during the first Gulf War like Safwan, Jabal Sanam, al-Zubair, Northern Rumaila oil fields, and Southern Rumaila Oil Fields (Figures 1 and 2).

Scintillation counters were used for exposure measurements and high purity germanium detectors for soil and sediment samples, surface and ground water samples and bio-

samples.

Selected measurements from exploration program results are shown in (Table 5). Modeling pollution transport from hundreds of destroyed artilleries to surrounding areas showed the following extensions of DU contamination in the area from 1991 - 1996 [17] [18] [19]:

- 1718 km<sup>2</sup> of soil contaminated with DU oxides and particles,
- 140,000 m<sup>2</sup> of channel sediments,
- 845, 100 tons of vegetation cover



**Table 5 : Selected Exposure and Soil Radioactivity Measurements [15]**

Sample Symbol
Location
Type of Sampled Target
Exposure $\mu$ R/hr
Activity Concentration in Soil (Bq/Kg)
Th234
U235
U235 / U 238
S-2-2
Northern Jabal Sanam
A1
28.6
3918
41.9
0.01069
S-2-9
Northern Jabal Sanam
T13
30.5
4401

57.1

0.0129

SN-1-2

Jabal Sanam

T1

36.8

11400

183

0.0167

SN-2-3

Jabal Sanam

T2

17.1

2550

47.3

0.0185

S-4-1

NW Jabal Sanam

T4

15.3

3408

30.9

0.009

S-5-3

North Safwan City

T5

16.3

7310

79

0.010

S-6-2

North Safwan City

T6

14.4

2019

36.3

0.017

R-1-6

Northern Rumeila Oil Field

T7

75.5

27800

375

0.013

R-3-2

Northern Rumeila Oil Field

T8

58

79100

119

0.014

R-4-3

Northern Rumeila Oil Field

A4

43

9700

70.3

0.007

RK-1-1

Southern Rumaila Oil Field

T9

80.8

55700

901

0.0161

RK-2-2

Southern Rumaila Oil Field

T10

51.9

40900

531

0.013

RK-3-2

Southern Rumaila Oil Field

T11

42.1

21700

198

0.009

RK-4-1

Southern Rumaila Oil Field

T12

43

31600

229

0.007

S-7-3

Jabal Sanam

A2

48

3120

25.1

0.008

T: Destroyed Tank      A: Destroyed Armored Vehicle

Risk assessment related to previous measurements showed that people in the western part of Basrah City, and the Iraqi and American troops received a total whole body radioactive dosage of (442 - 577) mSv [20] [21], mostly in the first six months of 1991 Gulf War military operations.

In 1999 - 2000 a follow-up exploration program in the same area was done by the Environmental Engineering Department (Al-Azzawi et al) through which site exposure, and soil sediments, water samples, and laboratory tests were also conducted in previously studied areas plus areas where most of the DU contaminated tanks were gathered, on the banks of Wafaa Al Qaied waterway causing further contamination [22] [23].

Results of this program indicated the existence of slightly higher radioactivity in some of the areas, but generally sand storms and the weathering process contributed to the dispersion of these contaminants to nearby populated areas. Table (6) shows conclusions of the the results of these tests and measurements.

**Table (6): Conclusion of (1999 - 2000) Exploration Program in Basrah**

**Type of Measurement**

**No. A \***

**No. B \*\***

**Range of Measurements**

**Background Levels**

**Units**

Exposure

120

17

8.2 - 11.6

4 - 7

μR/hr

Soil

120

22

80 - 788

42 - 70

Bq/Kg

Surface and Ground Water

75

—

Not detected

Not detected

Bq/l

Waterway Sediment Samples

13

10

50 - 85

30 - 40

Bq/Kg

\* No. A: Number of Samples

\*\* No. B: Number of Samples with Higher Activity

Also in 1999-2000 Al-Azzawi, Maarouf and Al-Mousori investigated the possibility of radiological contamination in Ninevah Governorate and its center Mosul City [Northern Iraq (Map 2)] after being attacked during 1999 by new generations (AGM 154 J50W) of Cruise missiles on three targets on the eastern bank of Tigris River in Mosul city. The program also involved checking the extension of Chernobyl plume on Iraqi territories after 13 years [24].

Results of this program (Table 7) showed slightly higher radioactivity in and around destroyed targeted areas than other areas of Mosul and Ninevah governorate. These results proved that Cruise Missiles also contain DU.

#### **Table (7): Conclusion of Ninevah and Mosul City Exploration Program of 2000 [24]**

##### **Type of Measurement**

##### **Area**

##### **No. A \***



**No. B \*\***

**Range of Measurements**

**Background Levels**

**Units**

Exposure

Ninevah

48

18

8.5 - 14

7

μR/hr

Exposure

Mosul City

62

21

8.5 - 14

7

μR/hr

Soil

Ninevah

29

5

80 - 107

—

Bq/Kg

Soil

Mosul City

48

18

100 - 142

—

Bq/Kg

Water

Mosul City

4

None

—

—

—

\* No. A: Number of Samples

\*\* No. B: Number of Samples with Higher Activity

Tawfiq, N. F. et al in 2000 [25] measured alpha-emitters concentrations in soil samples from different Iraqi cities using Solid State Nuclear Track detectors CR-39 and CN-85. Her team found out that high concentration radioisotopes of (7.8) ppm was measured in Muthana governorate. The Dutch troops later in 2003 refused to camp in the center of Muthana, Samawa City, due to high DU related radioactivity detection by those troops. After a few days they finally moved to a nearby desert area [26]. It was also confirmed by Dr. Durakovich that New York Guardsmen serving in Samawe during 2003 were exposed to DU [27]. Other cities with high radioisotope concentrations are Basrah (7.2) ppm, Nasria(Al-Shatra)(6.2) ppm. Generally, locations where the Iraqi withdrawing tanks were intercepted by US troops, and where the massacre of February 27 occurred- and Iraqi POWs were buried alive under the order of General Macaffery [28].

In 2000, Al-Gurabi, S. and her team measured DU related increases in radioactivity along the areas bordering Kuwait and Saudia Arabia. They also measured Northern Rumaila Oil Field areas and northwest Basrah City [3]. Results showed higher activity concentrations of DU related radioisotopes in all investigated areas except the center of Basrah City.

In 2001-2002 Butras, Wartan and Butras [29] measured radioactivity in three different areas of Basrah using Alpha and Beta measuring LB1200 detectors. The measured areas:

A: Iraqi-Saudi-Kuwaiti borders

B: Qurna, Zubair, Faw and Umm Kasir seaport.

C: Shatt Al-Arab district in Basrah

Results proved the existence of higher radioactivity measurements than background levels of  $(18 \times 10^{-3})$  mRm/hr in area (A) after 10 years of the war. Umm Kasir area registered  $(10 \times 10^{-3})$  mRm/hr. Normal background levels in the area are within the range of  $7 - 8 \times 10^{-3}$  mRm/hr [34].

In 2000, Al-Kinani, et al [30] collected (11) soil samples from Safwan, S. Rumaila and unarmed border zone using gamma radiation detector. Results indicated that (7) of these samples were contaminated with DU radioisotopes. Sample (SSI) U235/U238 ratio was found to be (0.00351) which indicates highly DU contamination under that destroyed tank. Other ratios ranged between (0.0041-0.0037).

Dozens of other studies were made and published in Arabic or English peer-reviewed scientific journals of various Iraqi universities. The published investigation programs were all conducted by well-known professors and researchers who followed the IAEA and other international scientific standards procedures. All research and radiological laboratory tests that were done in conjunction of the environmental department of the Iraqi Atomic Commission were searched and reviewed by periodic inspection teams of the IAEA who were checking the IAEC activities throughout the nineties until the invasion of Iraq in 2003.

A UNEP report in 2005 specified the existence of 311 sites related to DU contamination without any measurements [43].

## **2.2 Epidemiological Studies Related to (DU) Contamination Health Effects:**

Epidemiological studies about the correlation between (DU) radioactive contamination and the increase of malignancies incidence rates in Basrah Governorate have been noticed and studied by Al-Basra college of Medicine faculty members since 1995. Some of these studies were published in the University of Basrah Medical Journal. Others were presented in the two Iraqi conferences about the effect of economical sanction and the (DU) weaponry use against the human and environment in Iraq, held in 1998 and 2002 respectively.

Results of these studies pointed out very important facts concerning the direct correlation between DU radiological contamination and the resulted increase of the related diseases in geographically contaminated areas. Among others, the following studies are specifically important:

- 1998: Alim Yacoub et al [31] [32] presented an analysis of recorded cases of registered malignant diseases among children under 15 years of age in Basrah for the period (1990 - 1997). This analysis showed a rise of 60% in children's leukemia from 1990 to 1997. Also, a 120% increase in all malignant cases among children under the age of 15 for the same period were registered. The study also showed the shift of age distribution of leukemia cases towards younger, than 5 years of age from 13% in 1990 to 41% of total cases in 1997.
- 1998 Al-Sadoon, et al [33] showed a three fold increase in congenital malformations registered cases in 1998 compared to 1990. Congenital heart diseases, chromosomal aberrations, and multiple malformations all indicate exposure to teratogenic environmental factor.
- In 1998, Alim Yacoub et, al [34] also introduced an analysis of the incidence and pattern of malignant diseases in Basra from the analysis of the histo-pathological reports of

Basra University Teaching Hospital for the period 1990-1997. The study indicated that there was a rise of about 160% in reported cases of uterine cancer in 1997 compared to 1990 and an increase of 143% in thyroid cancer cases in 1997 compared to 1990 recordings. Also a 102% increase in breast cancer and 82% rise in lymphomas in 1997 compared to 1990. The shift in the types of the five major leading malignancies in Basrah in 1997 were malignant diseases such as breast, bladder, lymphomas, uterine, and skin cancers. While those of 1990 were malignant diseases of bladder, skin, breast, lung and larynx.

- 2002: Alim Yacoub, Imad Al-Sadoon and Jenan Hasan presented a paper [35] that examines the association between exposure to DU radiation and the rising incidence of malignancies among children in Basra through time sequence criteria, and dose-response criteria through the geographical shift of the increase of incidence rates in Al-Zubair and other western areas from less than 5/100,000 prior to 1993 to 22/100,000 in 2000 compared to only Al-Hartha area (north of Basrah) only prior to 1993 (with highest incidence rates of > 10/100,000 in 1993). They also tested the biological plausibility criteria through the shift of the increase of leukemia incidence rate towards younger ages of less than 5 years old after 1995. Figures 3, 4, and 5 conclude these results.

Yacoub et al, 2002, couldn't explain the reason for the constant increase of malignancies incidence rates among children in Al-Hartha district in northern Basrah City, figure 2, from (10 incidents / 100,000) to (42.7 / 100,000) in the year 2000. This can be explained by the existence of the largest electrical power generation and transformation facilities in Iraq of 800 MW. This power plant was destroyed during air raids several times in 1991. Nobody measured the radioactivity in Al-Hartha, which might also have been destroyed with DU bombing.

- 2002: Abbas Ali & Jawad Ali [26] presented an evaluation of chronic myeloid leukemia (CML) annual incidence which started to rise from 1995 up to the year 2000, when the increase began to plateau.



### **2.3 DU Effects on Human Health Pathological Studies:**

1998: Huda Ammash- Professor of Molecular Biology in the Science College of the University of Baghdad- presented a paper on the mechanisms of toxicity induced by free radicals resulting from irradiation with DU and ionization of the atmosphere in Iraq [37][38]. This paper pinpointed the need for DU toxicity researches on enzymes (SOD), Caralase, hydrogenates and Glyceraldehydes Dehydrogenates levels. She also presented the multiaborative cases on the DNA level where out of 50 studied cases, 29 cases were found with DNA abnormalities (with no hereditary evidence). Other multiaborative cases investigating the toxoplasmosis effect showed that out of 130 cases, over 65% more were infected than those recorded in 1989.

2002: Muhammed, Z.T. et al [39] published a paper about the effects of DU radiation on the human immune system enzyme. A group of (26) Iraqi veterans who were exposed to DU radiation with (43) control individuals were all subjected to tests for Adenosine DA Amines (ADN) enzyme activity. Results indicated mean activity of the enzyme of the exposed

individuals of  $(0.184 \pm 0.016)$  U/g protein, while the unexposed individuals enzyme activity  $(0.291 \pm 0.022)$ U/mg protein.

ADA enzyme activity in the exposed individuals were found to be significantly lower than the control group.  $P < 0.05$  significant correlation coefficient was found between ADA activity as an important immune enzyme and related clinical signs and symptoms related to defective cellular immune functions.

2002: Ammash, H., Alwan, L. and Marouf, B.A. published a paper (in Arabic) [40] about the results of Genetic hematological analysis for a group of individuals lives in DU contaminated areas southern Iraq. Blood tests for the (47) individuals who lived in Basra contaminated areas and other (30) individuals as a control group who lived in Baghdad were conducted with the study of other clinical and correlated factors.

Blood tests included hemoglobin concentration, packed cell volume test (PCV), total count (WBC) test and chromosomal changes and defects tests. Factors such as exposure type and exposure time due to nature of work were taken into consideration (45% of the studied groups are from Iraqi troops who were involved in military engagements of the Gulf War 1). The others were civilians who lived in contaminated areas.

The test results of the study clearly showed that a 21% of the studied individuals in Basrah group suffered a reduction in hemoglobin concentration of (9-13) g/dl.

The other 79% of the individuals from Al-Basrah studied groups with normal hemoglobin concentrations of (12-15) g/dl and (13-18) g/dl for males and females in the group respectively.

The blood Packed Cell Volume (PCV) test results showed that 25.5% of the Basrah study group showed abnormal (PCV) rates of (30-39)% less than the normal rate. One male's individual blood (PCV) was 3% higher than normal. Other individuals' blood (PCV) in the studied group had normal rates ranging between (40-54)%.

Total count of white blood cells (WBC) test results showed that 8% of the individuals in the Basrah study group have (WBC) less than normal which is 4000 c/ml or higher than the normal rate or (11000) c/ml. Control group individuals all had normal (WBC).

Compound chromosomal changes in the lymphocytes of periphral blood of the individuals of the Basrah studied group have been found at a ratio of (0.1118)% which is significantly higher than that of the control group. The ratio of dicentric and ringcentric chromosomal abnormality fraction was found to be (0.04479) which is also higher than ordinary ratio. Chromosomal damages were mostly in male veteran individuals. One case was that of a 13-year-old at the time of exposure in Al-Zubair contaminated area.

In 2000: From the Veterinary College of Basrah University, Khadier, A.A. et al [41] conducted a study to detect levels of DU related radioactivity in pastures and animals within the contaminated areas of Safwan, Al-Zubair, N. Rumaila, Jabal Sanam, Kharanje Village, etc.

Blood samples from sheep and other grazing animals were collected. Analysis of blood samples using Lyoluminescence and Track Detectors proved the existing of very small concentrations of radioisotopes in a few sheep that fed from and around the destroyed artillery and tanks within the studied areas. It is believed the polluted dust on the leaves

was the source of radioisotopes in the tested blood samples.

2002: Al-Sadi, H.I. and Sawad, A. [42] from the Veterinary College of the University of Basrah also presented a study about the pathological conditions of the animals in Basrah. The study reported the existing of three types of animal neoplasm; seminoma in rams, mesotheliomas in buffalo, and ovarian cystademonas in bitches.

These types of neoplasms have never been reported in these regions before the Nineties. Also some types of congenital defects in farm animals have been described.

### **3. 0 Conclusion:**

- 1- The USA and UK continuously used Depleted Uranium weapons against the population and environment in Iraq from 1991 until today.
- 2- Occupation forces in Iraq intentionally denied and covered up the types, locations and amounts of weapons that were used to prevent taking measures which could reduce health damages resulting from LLR exposure.
- 3- Occupation forces prohibited UNEP, WHO and other international agencies to conduct any exploration programs to assess the health risks to the people of Iraq of these radioactive contaminants.
- 4- Forbidding the release of any casualty statistics by the health ministry in Iraq right after the occupation is part of the crime that has been continuously committed against Iraq and Iraqis.
- 5- Exploration programs and site measurements proved without a doubt that the existence of DU related radioactive contamination all over most of Iraq (except the northern area of Kurdistan).
- 6- Published epidemiological studies in Basrah introduced a clear correlation between DU related exposure to LLR and the multifold increase of malignancies, congenital malformations and multiple malformations in detected DU contaminated areas.
- 7- Other pathological and hematological studies indicated the existence of chromosomal and DNA aberrations and abnormalities in the 1991 Iraqi Gulf War veterans. Other studies proved their effects on lowering the activities of the human immune system in exposed individuals.
- 8- Iraqi researchers' site measurements of 2000 revealed the fact that the Muthana governorate and Al-Samawa city were contaminated since 1991. This fact was proven by the Dutch troops in 2003, and then the American Guardsmen who served in that area after the invasion and confirmed exposure to DU contamination after coming back home by Dr. Drakovic.
- 9- Intentional continuous use of DU against the people and environment of Iraq is a crime against humanity due to its undifferentiated harmful health impacts on civilian long times after the military operations. Existing DU contamination in the surrounding environment is a continuous source of (LLR) exposure to civilians which can be considered systematic attacks on civilians in an armed conflict. Article 4 of the official regulations and Article 7 of the ICC.

#### 4.0 Recommendations:

In light of the stated facts and evidences, the following is recommended:

- 1- Occupation forces must allow UNEP to conduct a full exploration program in Iraq in order to assess human health and environmental damages caused by these weapons since 1991.
- 2- Occupation forces should clearly submit all necessary information and data about the types, amounts, and locations of all DU expenditures that have been used on Iraqi territories.
- 3- Occupation forces should allow WHO to conduct comprehensive health surveys and investigations in DU contaminated areas to help the Iraqi people and children coping with the consequences of DU related health damages.
- 4- Occupation forces should help in managing all contaminated wreckage and destroyed contaminated artilleries, top soil, waterways, bottom sediments through a comprehensive clean-up and remedy plan.
- 5- The doors for further research must be opened concerning studies about the impact of DU on the population and the environment in Iraq. This includes the release of statistics related to occupation crimes and casualties that have been committed against Iraqi people during the last two decades.
- 6- The accused administrations responsible for committing war crimes against Iraqi people and the environment through subjecting them to this suffering and gradual death as a result of DU weaponry use should be convicted and sentenced for war crimes and crimes against humanity.
- 7- The international community must work together to promote a resolution banning DU weapons as a first step to abolish these weapons from the army arsenals of the countries that currently use them.

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