Science Panel

Depleted Uranium Shells, The Radioactive Weapons

Perpetuation of War Damage by Radiation

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(Abstract)
Depleted uranium shells are “steel-penetrating arrows” made of uranium metal. Upon impact, they would punch a hole through the target, while uranium burns itself into tiny particles spreading out in the atmosphere. Inhaled or ingested, they would enter human bodies, causing disastrous damage due to internal radiation exposure and heavy metal poisoning. Radioactive contamination of the environment by DU would remain almost indefinitely, producing Hibakusha among the residents in the area over the generations. The heartbreaking image of Iraqi children suffering from illness caused by DU exposure is a prelude to a tragedy we will encounter in the days ahead.

If humankind wishes to treasure civilization it has created, it must forever renounce the use of force as means of conflict resolution. It is of great importance in human history that each individual voices ?No? to the path toward war and to the mobilization of science in arms development. Above all, sinister weapons must be banned without a moment?s delay. DU shells are atrocious radioactive weapons, which must never be allowed to use.

Prof. Katsuma Yagasaki, Japan

1. Depleted Uranium Shells

(1) What are DU shells?

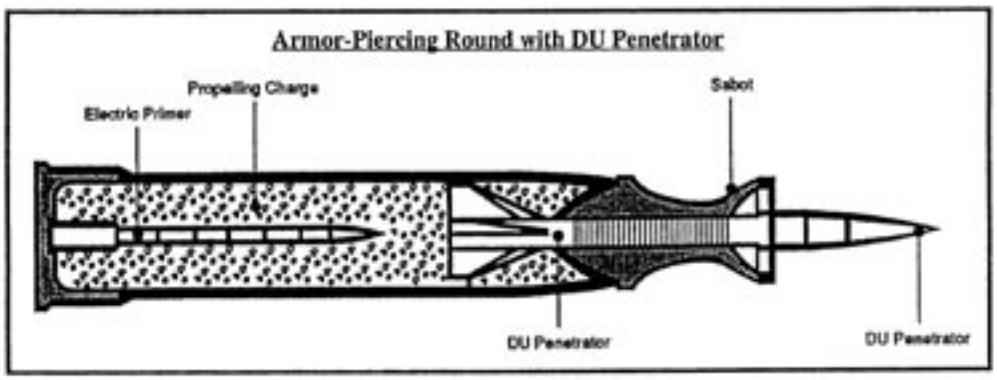
The term "depleted" seems to give the impression that DU is uranium that does not contain radioactivity any more, which is not the case. DU ammunition can cause serious radioactive contamination and is no less atrocious than nuclear weapons. Nuclear power plants are really dangerous facilities put in practical use on stipulation that they can "completely seal in radiation," while radioactive weapons commit an impermissible crime scattering radioactive materials in the environment.

DU weapons were developed as ordnance that could penetrate armored tanks and bounce around inside, burning and destroying them from within.

Ordinary shells contain detonating powders, which will explode on impact. Their purpose is to destroy steel-plated tanks from outside, but they are quite inefficient in terms of destructiveness. Steel bullets can hit, punch a hole and penetrate materials softer than steel, but they are not destructive enough to pierce steel-armored tanks, for they are not effective against bulky steel. This is how DU rounds, "steel-penetrating arrows" were developed as a weapon that could punch a hole through tanks, burn and destroy them from inside, taking advantage of the physical properties of DU it is extremely hard and dense. DU metal is the hardest and densest material of all. The density of DU is 19g/cm3, 2.4 times higher than that of iron, which is 7.9g/cm3. To enhance the degree of hardness, some 1 percent of molybdenum and titan are put to DU to make an alloy. Slender-shaped DU shells, upon impact, will punch a hole through the target, while becoming shorter with their heads scraped.

(2) DU Weapons as Armor-Piercing Incendiary Ammunition

DU shells are called armor-piercing firebombs, because they not only break through a steel armor but also burn up intensely. As armor-piercing rounds, they would punch out the bulky iron plate of tanks, invade their interior, and bounce around inside killing the combat crew, destroying tank facilities and burn them out. They would hit the target with their enormous momentum and pierce a hole with their kinetic energy. Compared to steel bullets of the same size, which have less density than DU rounds, the latter can make a hole in the target 2.4 times deeper than the former. And, while steel bullets must have the length of 30 cm, DU bullets only have to be 12cm to suite their purpose. Further, when fired, although DU shells receive the same air resistance as steel ones, they have less reduction of speed because they are 2.4 times heavier, which gives them longer range and bigger velocity in impacting the target. Consequently, DU bullets can destroy the target from a distance unreachable for the foe. See Figure 1 for the structure of DU rounds. Fig. 1



(3) DU Used in Bunker Busters

Further development has been made in DU weapons. Large-sized munitions called "Bunker Busters," which penetrate and blow up hard, concrete fortifications located several meters below the surface, have already been used in actual warfare. They are guided weapons in the form of bombs and cruise missiles designed to break through concrete hardened bunkers and other targets. They are loaded with DU penetrators, each of which weighing several tons. It is said that these bombs were used in huge amounts in Afghanistan to wipe out Al Qaeda fighters hiding in mountain caves, and then in Iraq to destroy Iraqi command centers located deep underground. The amount of DU used in Afghanistan and Iraq is estimated at more than 500 tons respectively.

2. Horrible Consequences of Internal DU Exposure

A major characteristic of DU munitions is that they are radioactive weapons. DU is radioactive metal emitting alpha ray, atomic nucleus of helium, accompanied by gamma ray. Energy of an alpha particle emitted from DU amounts to as much as 4.1 MeV (million electron volts), with which it can blow up 100,000 electrons bounding molecules and ionized pairs. However, it only flies short distance, a few centimeters in atmospheric air and not more than 40 micrometers, equivalent to the thickness of one sheet of paper, in body tissue or water. Consequently, the degree

of danger of alpha radiation largely differs according to what form of and from where one has been exposed to DU. We should examine each case according to: (A) when DU is outside the body either as cake, or as dust or particles; and (B) when DU dust or particles enter the body.

(A) External Exposure

When DU is in the state of metal, alpha ray, emitted from the uranium atoms existing at a distance of one-sheet of paper thick from the surface of the cake, will not come out of the metal cake. The only alpha ray given out will be the one emitted from the atoms located in the surface of the cake. Solid uranium cake of a few centimeters in diameter only emits several tens of millionths of the total amount of alpha radiations released by the atoms existing inside the solid. To cover up the danger of external exposure I will refer to later, one only has to speak about the state of radiation emitted from solid uranium. Here is an actual example of this: In 1997, when the fact about the U.S. firing of DU shells in Torishima island, Okinawa Prefecture was disclosed, the U.S. military first tried to clean things up with lies saying "DU is not a radioactive material." Grilled over the issue, they later had to restate that DU emits less radiation than a television set does. Uranium burns intensely when heated in the air, and it spontaneously ignites when it becomes dust. This is why DU shells, hitting the target, burn in intense fire upon impact and by the heat created. As long as they stay "outside the body even after becoming particles," they are not very hazardous. Although the whole alpha rays disintegrate into a size that can effectively be emitted out of the particles, the detected radiation dosage will be far less than the actual dosage, because alpha particles are blocked by environmental substances. Even when emitted over the human body, alpha rays will not go through the skin, slightly affecting the internal organs. In the case of DU existing outside the human body, the exposed dose measured per weight will be low. The nature of slow decay and this is why such DU is considered to be "low-level radioactive," with its danger often underestimated. This holds true only for the case of DU remaining outside bodies, and it in no way represents the actual danger DU can pose to human bodies. DU dust-like particles can enter human bodies, and once taken into the body, they will become tens of millions times more hazardous. Newly released data indicate that low-level radiation is more likely to cause biochemical abnormalities than intensive high-level radiation ("Consequence of the Chernobyl Catastrophe" edited by E. B. Burkova). It is wrong to make light of the hazard of low-level radiation.

(B) Internal Exposure

When uranium burns into particles, it will enter human bodies ingested with drinking water and food, or inhaled with air. In this case, the whole radiation and chemical toxicity will be released in the body. Effects of chemical toxicity differ according to the state of uranium, whether it is water-soluble or not, but there is no difference in its harmfulness as radiation. A depleted uranium particle of ten micrometers in diameter would release one alpha particle in every 2 hours, totaling more than 4,000 in a year. Alpha rays continue to injure human cells, giving no time for the injured cells to heal. Further, Uranium-238 decays into a daughter nucleus thorium-234, whose half-life is 24.1 day, and Th-234 decays into a granddaughter nucleus protactinium-234, whose half-life is 1.17 days. Pa-234 then becomes another element (U-234; 0.24 million years of half-life), forming a radioactive chain. Th and Pa release electrons to decay (beta decay). Six months later, Th and Pa will have reached "radioactive equilibrium," having the same radiation dose as U-238. At this stage, the penetrated DU particles now emit alpha particles, beta particles twice as much as alpha, and gamma rays accompanied with each decay.

As alpha particles does not travel farther than 40 micrometers, the whole damage will be given to the flesh 40 micrometers in radius. The annual radiation dose received by the exposed area of the flesh 40 micrometers in radius would amount to 10 sievert (as described later) only by alpha ray emitted from a depleted uranium particle of ten micrometers in diameter, ten thousand times higher than the dose limit.

One alpha particle passes hundred thousand atoms before it stops, blowing out hundred thousand electrons constituting a molecule. The destruction (ionization) of molecules will damage DNA, or will induce mutation in the cellular structure itself. There will be a great possibility of only one depleted uranium particle causing cancers and organ disorder. With the half-life of DU being 4.5 billion years, there emission 10,000 or 100,000 years later. This means once DU is inside the body, one will remain exposed to radiation as long as he/she lives unless it is discharged, while the environment continues to be polluted forever.

Regrettably, investigations carried out by the World Health Organization and other institutions do not go deep into the realities of internal exposure. For example, the U.S. Department of Defense states that it does not find relationship between DU and the cancer incidence in Iraq (from a scientific report made by the Research and Development Corporation on cancers and

DU on the Pentagon budget). The investigations conducted by the WHO and European Community made the same conclusion. These researches determine that the radiation level found in Balkan and Iraq is not harmful to health. Yet in reality in both places there are many cases of babies born with birth defects and the high incidence of cancers. What is the purpose of those researches? It is fair to say that their role is to cover up the facts about the damage caused by DU and the responsibility for the use of atrocious weapons. Meanwhile, a non-governmental organization called Uranium Medical Research Center conducted a urine test instead of the environmental research, and found the presence of high levels of uranium in Afghan citizens.

3. Difference between DU Munitions and Nuclear Weapons

(1) Nuclear Weapons

Nuclear Weapons take out immense energy generated by atomic fission of U-235 and plutonium-239 (atomic bombs), or by nuclear fusion converting hydrogen nucleus int helium nucleus (hydrogen bombs). Hydrogen bombs use as detonators high temperatur and high pressure produced by atomic bombs. The horrible damage caused by the atomic bombing of Hiroshima and Nagasaki more than fifty years ago is widely recognized as a testimony to foolishness of humankind.

In Hiroshima and Nagasaki, in terms of activity, several dozen kilograms of radiation were dispersed (this is a simplified explanation, while the activity should be expressed by the number of radioactive atoms to be accurate). This amount of radiation caused tremendous damage. A-bomb radiation is characterized by the process in which an atomic nucleus of uranium is split up into almost exact halves, and the newly produced daughter nucleus with excessive neutrons release electrons from neutrons transforming into protons one after another, so that they can become stable. This process is called beta decay and the electrons produced are named beta rays. Their half-life is very short, and most of them disintegrate violently. This is how extraordinary radiations rushed about in the air immediately after the atomic bomb was dropped, creating a state that could be well described as a melting pot of radioactivity. But these radiation rays rapidly decay with the passage of time, and after weeks, months and years they would finally vanish.

(2) DU Munitions as Radioactive Weapons

Contrary to nuclear weapons, DU munitions do not use either nuclear fission or fusion.

Since they are not weapons that cause destruction by producing extraordinary amount of energy, they should be distinguished from “nuclear weapons”. Yet they will disperse radiation in the environment causing grave damage. Looking into DU munitions in terms of radiation they produce, they have two characteristics.

(A) First, the used amount of radioactive atoms of DU weapons dispersed into environment in the real wars was far beyond that of the atomic bombs dropped on Hiroshima and Nagasaki. It is estimated that in the First Gulf War, 320 to 800 tons of DU were used, scattering indeed 14,000 to 36,000 times more radiation than in Hiroshima. In the recent wars in Afghanistan and Iraq, at least 500 tons of DU shells were said to be dropped

(B) Second, while most of the radiation released by the atomic bombs in Hiroshima and Nagasaki had very short half-life periods, DU has an extremely long half-life of 4.5 billion years. Dose amount of DU will last in the same level of as ever even after tens of thousands years. Residents in the DU-affected area will have to live forever, for generations to generations, under threat of radiation. Humankind has never experienced such horrible damage of war. Any radioactive weapons, as well as nuclear weapons, must never be allowed to use.

4. DU and Radiation

(1) Enriched Uranium and Depleted Uranium

Nuclear weapons and power use tremendous energy produced by atomic fission. Atomic fission is an atomic reaction induced when a neutron bounces into an atomic nucleus. Only particular nuclei are fissionable, and those that have been put into practical use are uranium-235 and plutonium-239. Plutonium is produced in nuclear reactors, while U-235 is extracted from natural uranium. Elements with 92 protons in atomic nucleus are called uranium, which has three isotopes according to the number of neutrons in atomic nuclei: U- 235 has 143 neutrons; and U-238, 146. Natural uranium contains only 0.7 percent of fissionable U-235 (Table 1), so that in order to cause consecutive fission, it is necessary to enrich U-235. To be used in nuclear power generation, it has to be enriched 2 to 4 percent, and almost 100 percent to be used to make nuclear weapons. The product is called enriched uranium.

After the removal of U-235 in the enrichment process, the content of U-235 in the uranium would be reduced to 0.2 percent. This kind of uranium is so called depleted uranium (DU), because it has minimum fissionable uranium. Most of DU is U-238

	Characteristic Property	Radioactive Half-life period	Content
^{234}U U-234	Not fissile	2.45 hundred thousands years	0.0054%
^{235}U U-235	Fissile	0.704 billion years	0.711%
^{238}U U-238	Fissile only with high velocity neutron. Transform to plutonium by absorbing a neutron	4.47 billion years	99.283%

Table 1 Natural Uranium

(2) Radioactivity

Radioactivity and Radiation

Atoms consist of a nucleus with electrons surrounding it. Radioactivity is a property of an atom trying to release materials (helium nucleus and electron) and energy from its unstable nucleus to become another atom with more stable nucleus. It is used also intensity of atomic disintegration per second. (Japanese term of "Hoshano" has been used commonly for the meaning of radioactivity and radioactive materials.) This process of the transformation of atom by the release of radiation is called decay. The materials and energy discharged from nucleus are called radiation. There are three kinds of radiation: alpha ray produced by the release of helium from the nucleus of an atom; beta ray, produced by the release of electrons; and gamma ray, produced by the release of energy as electromagnetic wave (Table 2). All uranium is a radioactive element that emits alpha rays, together with gamma rays.

	Emitting material	Electric Charge of emitting material	Penetrating power
Alpha ray	Nucleus of helium	positive bivalent	Small Stopped with thickness of a sheet of paper
Beta ray	Electron	Negative monovalent	Small Stopped with thickness of several sheet of paper
Gamma ray	Electromagnetic wave	Non	Very large

Table 2 Category of Radiation

Half-Life Period

Atomic disintegration always takes place in proportion to the number of atoms existing at the time. A half-life is a period that the number of atomic disintegration (or the number of the radioactive atoms) is reduced to half. Radioactive half-life for uranium isotopes is placed in Table 1. Comparing different kinds of radioactive materials of the same atomicity, those with more atoms decaying per unit time have shorter half-lives. All radiations, by blowing off the electrons in molecules, change the nature of cells and defunctionalize them, inducing birth defects and cancers. It is said that radiation with greater penetrating power is less effective in blowing electrons. Biological half-life is a period that the number of atoms ingested inside body is reduced to half by discharging. It was reported that half-period of water-soluble DU compounds is almost one year, while, insoluble particle is much more difficult to go out. The smaller the size of particles, the more difficult to be discharged. To measure biological half-life is very difficult, as only a small part of radiation can be detected from outside of body.

Radioactive Chain

Daughter nuclei produced by the uranium decay are still more radioactive, and granddaughter nuclei produced as their parent nuclei disintegrate are radioactive as well. In this way, uranium forms "radioactive chain,"as it decays. In time, the numbers of chain atoms become balanced if the half-life of daughter nuclei is shorter than that of mother nuclei (radioactive equilibrium), which will lead to a simultaneous or a same ratio of decay of all elements along the line of the chain, just like the flow of the river. In the case of DU, it will reach the equilibrium with daughter and granddaughter nuclei in about six months, with threefold increase of radiation dosage, which makes DU in this stage further hazardous, as described at the section of internal exposure..

Intensity of Radioactivity

The intensity of radioactivity is measured in the number of decays per second (Bq: becquerel) or units of curie. One curie is one gram of radium radiation, quantity of radioactive material that will have 37,000,000,000 decays in one second.

Absorbed Dose

The effective damage of the radiation to human bodies depends on the number of ionization (the number of electrons in the cell molecules blown by radiations). The number of ionization is measured by the quantity of energy radiations gave to the exposed tissues. A unit called gray is called to measure the absorbed dose; one gray is one joule of energy deposited in 1kg of a material.

Dose Equivalent: Biological Effects

Biological effects varies according to the kinds of radiations, so that a unit called sievert is used to derive a quantity called equivalent dose. For

example, one gray of gamma rays is one sievert, while that of alpha rays equivalents to 20 sieverts. This well explains in estimating probabilities of "irreversible damage" which happens when multiple chains of DNA in chromosomes are injured at once and rejoined erroneously, Alpha rays with larger energy and shorter traveling distance are more likely to cause irreversible damage than gamma rays with greater penetrating force, or density of ionization is much larger for alpha ray than gamma ray.

(3) Problem of DU Disposal

Over fifty-years of nuclear arms race in the postwar period not only resulted in the huge stockpile of nuclear weapons but also produced enormous amounts of deplete uranium as wastes. In 1991 the U.S. Nuclear Regulatory Commission announced that 10 billion pounds (4.5 million tons) of depleted uranium wastes are in storage at the U.S. Department of Energy. At the same time, in the uranium enrichment plant in Western Europe, 0.3 million tons of DU wastes were preserved. The disposal and storage of this radioactive material that required an extraordinary cost had become a grave issue of concern. The DOE announced that it would offer DU for free for its applied use. In 1972, Los Alamos National Laboratory made public that it had started a development research on the use of DU as material for anti-attack cannons.

5. Conclusions

In complete disregard of the United Nations and objective facts, the Bush Administration of the United States pushed ahead with a unilateral preventive war against Iraq, under the pretext of "expelling bandits"who commit acts of terrorism and possess weapons of mass destruction. The U.S. even hinted at expanding the war target to the "axis of evils." Such a war must never be confirmed.

In the war on Iraq, cluster bombs, fuel-air explosion bombs (Daisy Cutter) and other kinds of atrocious weapons were used. What amounts to an impermissible challenge to human beings is that DU rounds were massively used as one of the key weapons in the war.

After the First Gulf War and the Balkan War, where DU weapons had been used, facts about the DU-caused damage were reported. Such damage as several to twenty folds increase in the incidence of cancers and thyroid abnormalities as well as in the rate of babies with birth defects were not only limited to the residents of the affected countries. Those soldiers who had been sent there also suffered the same damage, referred to as Gulf War Syndrome or Balkan Syndrome. DU munitions were used in huge amount in the war against Afghanistan, and it has already been revealed that high levels of uranium entered the residents? bodies. Iraq, the already DU- contaminated country as the result of the First Gulf War, was once again exposed to this radioactive toxic material. It is inevitable that this country will face further grave consequences. In 1996, U.S. forces conducted firing exercises using DU shells in Torishima, Okinawa. Residents of Kumejima, an island located near the exercise site, are still tormented by the fear toward radiation.

In the 20th century, humankind experienced two world wars that caused massive killings and destruction. The mass destructions in those two wars, with the exclusion of life and cultural heritage, were in some respect "reversible." However, the war with radioactive DU shells bring about a permanent radioactive contamination to the environment of the combat areas, and continuous destruction of life making the residents Hibakusha over generations. DU will cause fatal damage that human being has never experienced before. DU munitions, together with nuclear weapons, must never be allowed to use any more. With such highly progressed science as it is, now is the time for humankind, if it wish to treasure the civilization it has created, to become determined to renounce forever the use of force as means of conflict resolution. At the same time, all citizens who wish to live in peace must never allow any horrible act of ?mobilizing science in the development of arms, which are means of destruction and killing.? Looking straightly at the images of Iraqi children suffering thyroid abnormalities, birth defects, and with their stomach swollen with abdominal dropsy, each one of us must raise voice against DU weapons and against war.

Let us hand over a green earth with abundant human wisdom and rich cultural heritage to our descendants in the 22nd century. For this, I do hope that this article will be found informative.

(This article is written for an educational text of depleted uranium munitions for Japanese general citizen and is translated to English for the World Uranium Weapons Conference 2003.) (August 2003)

Chris Busby PhD, UK

Depleted science: Health consequences and mechanisms of exposure to fallout from depleted uranium weapons

Contribution to international DU conference, Hamburg Oct 16-19th 2003

Occasional paper 2003/06; July 2003
Aberystwyth: Green Audit

1. The DU story is part of a wider concern

For there is nothing hid that shall not be manifested;
neither was anything kept secret, but that it should come abroad
Mark 4,22

Why is there concern about the health effects of Depleted Uranium? Would there be equivalent argument about the health effects following the use of Tungsten in tank shells or lead in bullets? The answer is straightforward: everybody knows that Uranium is radioactive and everyone knows that radiation exposure leads to cancer, leukemia and genetic damage. No one wants to be exposed to ionising radiation.

So why is such a weapon being used, if this is the case?

The answer is tied to a much larger and more serious issue. This is the issue of the health consequences of exposure to low doses of radiation from nuclear pollution of the planet, a subject which I have studied for more than fourteen years. The reason that DU is employed is that the weapons are astoundingly successful and have revolutionised warfare, rendering the tank and its armour useless. In addition, its use represents a route for the nuclear industry to rid itself of a waste product which would otherwise be expensive to dispose of. But the downside is that the material clearly represents a radiation hazard which is indiscriminate: battlefields are going to be contaminated and civilian populations are going to be exposed. There is an upside and a down-side. The war will be won but the method will be illegal within contemporary accepted moral arguments. Human rights will be infringed by a randomly dispersed and thus indiscriminate radioactive weapon of mass destruction.

Since 1945, these arguments have been endlessly rehearsed for man-made nuclear pollution. First there were atmospheric nuclear weapons tests which caused global contamination with fallout, followed by pollution from the civilian/military nuclear power cycle which in the UK means pollution from Sellafield. The European Committee on Radiation Risk have recently calculated that more than 60million people have died from cancer as a result of these exposures (ECRR2003) yet Sellafield continues to operate, and nuclear power stations continue to release radioactivity to the environment. Owing to the application of false scientific models, this behaviour is sanctioned legally, and the situation is getting worse. In May 2000, the European Union adopted the 1996/29 Euratom Basic Safety Standards Directive which explicitly permits the re-cycling of radioactive substances into consumer goods.

Let us try to fit the dispersion of Depleted Uranium into this perspective. In terms of disintegrating atoms, radioactivity is measured in Bequerels. One Bequerel represents one disintegration per second. This is a reasonable way of quantifying amounts of radioactivity. The average Natural Uranium content of soil is about 10-20 Bequerels per kilogram, including all the Uranium isotopes. Most people excrete as much as 0.1mBq (0.0001Bq) per litre of Urine as a result of absorption of natural Uranium in food they eat. Pure Depleted Uranium contains about 12,400,000Bq of U-238 per kilogram and in Kosovo, some soil samples analysed by the United Nations Environment Program (UNEP) contained 250,000Bq/kg (UNEP 2001, Annex). The 350 tonnes of DU used in the first Gulf War represents 4.3 TBq (4.3 x 1012 Bq) of Uranium alpha activity (13.0 x 1012 if the radioactive beta emitting daughter isotopes are included-more of these below). If Dai Williams (2003) is correct and about 1700 tonnes were used in the latest war, then that represents 63 TBq of activity dispersed mainly into a populated area of perhaps 100km2 . This gives a mean density of deposition of radioactivity of 630,000Bq/m2. These sums are instructive and are collected together in Table 1.

These activity comparisons are given just to get some feel for the amounts of radioactivity involved, and to show that the dispersion of Uranium in various recent battlefields is not trivial, as the military and some politicians regularly imply. But the comparisons are slightly misleading because we are not dealing with the same isotopes as were released by weapons fallout which is composed of alpha beta and gamma emitters. Battlefield DU fallout is in the form of microscopic alpha and beta emitting particles. U-238 is an alpha emitter. The U-238 daughters, Protoactinium-234m and Thorium-234 are beta emitters. Having short half-lives, they are in equilibrium and therefore have the same level of activity in a sample of DU. In an area contaminated by DU it is the beta radiation that is detected because it has a range in air of about 30cm unlike the alpha particles which are very short range.

Maj Wechselmann, film maker, Sweden

We can find a better comparison for DU. As an alpha emitter and long lived environmental particle DU is more comparable with Plutonium-239, a substance released by Sellafield and a major

contaminant of the Irish Sea. Plutonium in the environment is also in the form of micron sized oxide particles.

Table 1. Mean density of deposition of radioactivity from DU in the two Gulf Wars and Kosovo including decays from U-238 and beta daughters Pa-234m and Th-234 compared with other radioactive contamination.

Event	Activity released or estimated deposited	Mean activity density Bq per square metre (area)
10 tons of DU in Kosovo	0.37TBq	3700*
350 tons of DU in Iraq 1	13 TBq	130,000 (into 100 km^2)
1700 tons of DU in Iraq 2	63TBq	630,000 (into 100 km^2)
Global weapons fallout Strontium-90 (Sr-90) Northern Hemisphere lat. 50-60deg (UNSCEAR, 2000)	73.9PBq	460
Chernobyl 30km Exclusion Zone measured Sr-90 (IAEA)		37,000 to more than 111,000
UK North Wales Radioactive Sheep restrictions measured Caesium-137 (Cs-137)		15,000 to 30,000
UNSCEAR definition of contaminated area. (Cs-137)		> 37,000
Irish Sea cumulative Plutonium from Sellafield 1952-1996 [Busby, 1995]	1350TBq	20,000

* I measured 4000Bq/kg in Gjakove, Western Kosovo, in Jan 2001 in a car park, but these values are averages based on an assumption about the area into which the material has been dispersed.

Like DU, these Plutonium Oxide particles are also long lived and mobile. Plutonium from Sellafield has been measured in autopsy specimens across the UK, in sheep droppings on the east coast of England 100 km from Sellafield at the same latitude and even in the teeth of children up to 200 km from the site in south east England. Both Uranium-238 and Plutonium-239 are alpha emitters, although Plutonium has no beta emitting daughter isotopes in SECULAR equilibrium. U-238 has a very long half life, 4500 million years, so owing to its much shorter half life of 24,100 years, the specific activity of Pu-239 is far greater. It is 2.3TBq/kg. But this means that 350 tons of DU (or 4.30TBq of U-238) is equivalent in activity to about 2 kg of Plutonium-239. What would governments of the world say to a war in which one army caused the intentional scattering of 2kg of Plutonium-239 over a populated area? What would the ethicists and moral philosophers say? Or ordinary members of the public? What would happen in New York or in London if 2kg of Plutonium-239 was dispersed among the public? The emergency services are geared up in the UK to evacuate whole cities if such a 'dirty bomb' was exploded by terrorists. Actually, for reasons which I shall enlarge on, in terms of health deficit, what has been done in Iraq and Kosovo, possibly also in Afghanistan is much worse. Yet nothing is said by the regulatory authorities. Worse than this: they develop models and enrol scientists in an attempt to minimise any perception of harm and routinely deny or marginalize evidence that shows that the use of DU has had major and serious effects. I compare U-238 and Pu-239 in Table 2.

Table 2 Comparing Plutonium-239 and Uranium-238 in the environment

	Uranium-238	Plutonium-239
Environmental form	0.2-2μ oxide particles	0.2-2μ oxide particles
Density of material $g.cm^{-3}$	(UO_2) 10.9; (U_3O_8) 8.3	(PuO_2) 11.46
Solubility	Insoluble	Insoluble
Environmental Longevity	Long lived	Long lived
Main radioactive emissions	Alpha + beta +beta	Alpha
Alpha particle energy	4.19MeV	5.15MeV
Half life	4.51 billion y	24400y
Specific activity	37.2MBq/kg ($\alpha + \beta$)	2.3TBq/kg (α)
Main present contamination source	DU	Fuel reprocessing e.g. Sellafield
Mass for equal activity	175 tons	1kg

I have compared Plutonium and weapons fallout with DU to demonstrate that we are dealing with the same problem, the health effects of low level exposure to radioactive substances that irradiate our bodies from the inside. The weapons fallout, and other pollution from nuclear sites like Sellafield has been responsible for the present cancer epidemic, the one that everyone has experienced. It has been a major project of the nuclear military complex, and for governments

who have been involved in releases of radioactivity, to cover up the link between these exposures and cancer or other ill health. This is why all these committees are controlled and steered by the same people. Recognition that DU caused cancer, leukaemia or lymphoma at the doses experienced by those who were contaminated after its use would lead to inevitable recognition that the weapons fallout substances, the Strontiums and Plutoniums and Caesiums also caused cancer, leukaemia and lymphoma. The reverse is also true. Recognition of the cause of the Sellafield leukemia/lymphoma cluster would lead to reassessing the risk models to the point where it would be clear that DU would have serious health effects. This is the origin of a massive cover up which extends to the cancer registries and the cancer research organisations.

2. Green Activists

First they laugh at you, then they attack you, then you win.
Gandhi

The truth about the health effects of low level radiation has been covered up by the nuclear /military lobby in many ways for about 50 years. I wrote about this in Wings of Death (Busby 1995) and there I explained how different levels of control and bias had been employed to keep the public from realising that they were being systematically poisoned by radioactivity. Others have made this point. John Gofman, once a very senior figure in the nuclear establishment put it well: the nuclear industry is conducting a war against humanity. Part of the reason behind the success of this cover-up has been that the process has been tied in with Military and State security in the countries that have nuclear weapons. The process extends to the highest levels. The World Health Organisation (WHO) is tied to the International Atomic Energy Agency by a 1959 agreement which prohibits them from researching the health effects of radiation. This is why we hear that there have been no increases of cancer due to Chernobyl. This is why the WHO take the view that DU is not a health problem. This why the European Commission adopt the EURATOM safety standards and the radiation safety laws are predicated on the advice of the ICRP, a self selected and unaccountable organisation that is part of a network of revolving doors in which the same people pass in and out saying the same things and agreeing with one another.

From very early on I felt that to change this situation a scientific analysis was not enough. There had to be a political analysis as well, and particularly an analysis of power. The power of the nuclear/ military establishment lies in institutions rather than in money. It is these institutions that lend credibility to their position. Increasingly, though the liberalisation of universities and their research funding, it is the grants that drive the direction of science and formulates its current 'Truths'. It is not the quality of the research that decides whether it is published and eventually influences policy. It is the acceptance of the research results into the required institutional view. If you write a scientific paper and the editors or their referees don't like it, they reject it.

You are not told who the referees are. For the Green Activist, who wishes to change this, the answer then is to ignore these institutions and create new ones. What is the point of sending rigorously argued manuscripts to scientific journals if these journals are controlled by the nuclear industry scientists, those they support with research grants and money?. What is the point of sending out Press Releases to the media if they are put in the waste bin?

As a result of the Green Activist approach, the Low Level Radiation Campaign has persuaded the UK government to set up a new committee to examine these effects. We pointed out, following the 'Mad Cow Disease' committee failings that the only way to get to the truth in science advice was to fund both sides and have them argue the case out in committee. The first committee of this kind is this new Committee Examining Radiation Risk form Internal Emitters (CERRIE, www.cerrie.org). Here, there are scientists from both sides of the debate on low-level internal radiation arguing out the various pieces of evidence that the ICRP risk model is in error and that internal radiation exposure, like that from fallout, from Plutonium, or DU represents a serious health hazard. CERRIE reports finally in 2004, but its preliminary report was considered at an international workshop in Oxford in July 2003. The report drew attention, for the first time, to the existence of major scientific uncertainties in the area of risk from internal radioisotopes.

There is one other independent institution which I helped to set up. This is the European Committee on Radiation Risk, based in Brussels (www.euradcom.org). This committee was intended as an alternative ICRP. It has over 40 independent experts in radiation risk, mainly from Europe and the ex-Soviet Union but some from the USA also.

It includes ethicists, doctors, physicists, geneticists, biologists, politicians and philosophers. Together with Prof. Inge Schmitz-Feuerhake and Prof Alexey Yablokov, I launched the ECRRs new radiation risk model in Brussels on 30th June [ECRR2003]. The model incorporates weightings factors for internal radiation exposure. These are

based on arguments and evidence which I shall examine now. For DU the weightings are as high as 1000-fold

Let me now concentrate on reviewing where we are in the investigation of Depleted Uranium.

3. The health effects of internal irradiation by man-made radioisotopes and new forms of natural isotopes.

I will summarise briefly here the theoretical and epidemiological evidence that the ICRP external model is in error by orders of magnitude when used to predict or explain the consequences of internal irradiation. A fuller explanation is given in ECRR2003.

3.1 Theoretical considerations

External radiation produces ionization tracks in tissue that are uniformly distributed. Thus each cell receives on average one track per year and the linear dose response used by the ICRP to predict cancer from the Hiroshima survivors breaks down if there is more than one track intercepting a cell in the time it takes for the cell to repair damage, about ten hours. For internal sequentially decaying isotopes and for internal long lived, hot (or warm) particles the probability of a cell local to the internal decay receiving two or more hits is very much higher than the equivalent probability for the same dose delivered externally. There are two consequences. The first is that the cell response is in the 'dose squared' region of the accepted ICRP model and the dose response in no longer linear. This is because the probability of a DNA double strand break occurring increases sharply for two or more hits to the cell. Such a lesion carries a high degree of certainty that a fixed mutation will follow. The second possible consequence is that the first hit to the cell will either induce a repair replication cycle in the hit cell, or if the cell is killed, in local cells which will begin to replicate to supply a replacement. Whilst replicating and repairing the initial lesion, a second hit at the critical point in the replication process will cause a fixed unrepairable mutation. This is the second Event Theory. There are further problems with internal isotopes which relate to their chemical affinity for DNA. Both Strontium (e.g. Sr-90, Sr-89) (Sr++), Barium (Ba-140, an Auger emitter) and Uranyl UO_2++ ions bind strongly to DNA (Wu et al, 1996) and so their decays will be extremely hazardous since they are localised near the target of interest. Work with the covalently bound Auger emitter Iodine-129, and also manmade Auger emitters like Cr-59 with bind to DNA show that these localisation effects carry very high risks which are not modelled by their apparent average doses. U-238 itself is an Auger emitter (31 % decay 10keV) and the high concentration gradient of of UO_2++ ions near the surface of a UO_2 particle would result in a high level of DNA localisation near the particle. Particles are, of course, highly likely to cause second event and multiple hit effects to nearby cells and the local doses from DU particles are considered below.

In the last ten years, evidence has emerged that low doses of radiation cause genomic instability in cells that are hot, but also in cells that are near the cells that are hit, up to about a 300 cells radius. Using computer controlled microbeams, individual cells can be targeted and the effects in nearby cells counted using various endpoints. In all these experiments, the dose response is very clearly non linear and increases sharply up to two or three hits per cell when it saturates. Miller et al (1999) have shown that cancerous transformation is almost exclusively caused by two hits rather than by one hit/ the effect for chromosome aberration as an end point seems to saturate after three hits (Prise et al, 2002). The cell volumes around damaged cells respond to the damage through a communication field, and therefore it is the location of radiation doses and ionisation effects within this field that is important in establishing future effects in the tissue like cancer. It is clear that physics no longer informs us of the effects of radiation at the cellular level. The key problem is that the evidence shows that concentration of ionization in a small volume of cells, or inside a single cell results in very high yields of mutations. It is high local ionisation density that is important, not dose; but this fact has been obscured by experiments with such high densities of ionisation that cell killing is the result. This is why the hot particle experiments show such equivocal results. These new discoveries in biology make a nonsense of the basic science underpinning the ICRP averaging models and therefore we have to look to appropriate epidemiology to see what the health consequences of exposure to these novel isotopes and forms are. To use epidemiology of externally irradiated groups to inform on internally irradiated groups is not using scientific method (Busby 2001 RS, Busby 2002 BNES).

3.2 Epidemiological considerations

If we cannot extrapolate from external radiation and Hiroshima, and we cannot use linear no threshold dose responses to mathematically model health effects where does that leave risk

assessment? The scientific answer is that we have to look at the effects themselves and use them to define risk. This is done by epidemiology of populations exposed to the radiation sources we are interested in. It is not good enough to say that the model does not predict the cancers, as the risk agencies said about the Sellafield leukaemia cluster. If the models is theoretically unsound, we must re-examine the issue and consider whether the cancers were caused by the radiation. When we do this for the famous Sellafield child leukaemia cluster, we find that the error in the ICRP risk model needed to account for the cancers is about 300-fold. Looking at the other leukaemia clusters the error needed to explain the cancers is between 300-fold and 2000-fold. This may seem like an enormous error, but if it consistently turns up, we should as scientists begin to look at how it can occur. Tamplin in 1972 examined hot particles of plutonium and concluded on the basis of theoretical assumptions that they, were more hazardous that the ICRP model suggested by a factor of 115,000, so these large numbers are not as silly as they may seem. They essentially represent the difference between local dose to tissue and averaged dose to body from a hot particle. And since it is the tissue that develops the cancer over a long period by amplification through cell division of various DNA lesions, it is not surprising that it is the tissue dose that is important, and not the whole body or whole organ dose.

Although many studies of nuclear sites, downwinders, and other contaminated individuals have pointed to large errors in the ICRP model (see Busby 1995 and the web site: www.llrc.org) it was only after Chernobyl that we were able to obtain sufficiently unequivocal evidence. Despite the cover-ups in the ex-Soviet territories and the efforts of the cancer agencies (e.g. IARC, IAEA, WHO) to deny any effects two sets of evidence emerged which falsified the conventional position that the only effects of Chernobyl were the deaths of a few liquidators and some thyroid cancers. There were two pieces of evidence that forced the UK government into a reappraisal of the issue of internal radiation. The first was the Chernobyl infants and the second was the minisatelite DNA mutations.

3.3 The Chernobyl infants

Following the Chernobyl accident in 1986, the cohort of children who were exposed in their mother's womb to radioisotopes from the releases suffered an excess risk of developing leukaemia in their first year of life. This 'infant leukaemia' cohort effect was observed in six different countries. It was first reported in Scotland [Gibson et al., 1988], and then in Greece [Petridou et al., 1996], in the United States [Mangano, 1997] and in Germany [Michaelis, et al.. 1997].

Busby and Scott Cato examined the relationship between the observed numbers of cases and those predicted by the ICRP model. For the first time, the specificity of the cohort enabled them to argue that the effect could only be a consequence of exposure to the Chernobyl fallout. There could be no alternative explanation.

Because the National Radiological Protection Board had measured and assessed the doses to the populations of Wales and Scotland and because they themselves had also published risk factors for radiogenic leukaemia based on ICRP models it was a simple matter to compare their predictions with the observations and test the contemporary risk model. The method simply assumed that infants born in the periods 1980-85 and 1990-92 were unexposed and defined the Poisson expectation of numbers of infant leukaemia cases in the children who were in utero over the 18 month period following the Chernobyl fallout. This 18 month period was chosen because it was shown that the in utero dose was due to radioactive isotopes which were ingested or inhaled by the mothers. Whole-body monitoring had shown that this material remained in the bodies of the mothers until Spring 1987 because silage cut in the Summer of 1986 had been fed to cattle in the following winter. The result showed a statistically significant 3.8-fold excess of infant leukaemia in the combined Wales and Scotland cohort ($p = 0.0002$). The leukaemia yield in the exposed in utero cohort was about 100 times the yield predicted by the ICRP model. Table 3 compares the effect in the three main studies. In this table, the B cohort were those children exposed to the internal exposure from Chernobyl in utero in the 18 month period following the event and born between June 1987 and January 1988. These exposure periods were defined by the whole body monitoring results. The control periods A and C were the ten years before (1975-85) and the four years after 1988 for which data was available.

The possibility of the effect being due to chance may be obtained by multiplying the p-values for the null hypothesis that the effect was due to chance in each of the separate countries to give an overall p-value less than 0.0000000001. Thus it was not a chance occurrence: it was a consequence of the exposure to low-level radiation from Chernobyl.

The infant leukaemia results represent unequivocal evidence that the ICRP risk model is in error by a factor of between 100-fold and 2000-fold for the type of exposure and dose, the latter figure allowing for a continued excess risk in the cohort being studied.

Table 3 Unequivocal evidence of ICRP risk factor errors: comparison between infant leukaemia rates after Chernobyl in Wales and Scotland and similar data from Greece and from the former Federal Republic of Germany

Group	[a] Wales and Scotland	[b] Greece	[c] Germany
Exposed cohort B			
Cohort size	156,600	163,337	928,649
Number of cases	12	12	35
Rate	7.67	7.34	3.77
Unexposed cohort A + C			
Cohort size	835,200	1,112,566	5,630,789
Number of cases	18	31	143
Rate	2.15	2.79	2.54
Risk Ratio	3.6	2.6	1.5
Cumulative Poisson Probability	0.0002	0.0025	0.02

3.4 Minisatellite mutation rates in Chernobyl children

The ICRP model of genetic mutation after irradiation is based, like ICRP's cancer risk model, on the Hiroshima lifespan study yield of gross genetic effects and also studies of radiation effects in mice.

Although subtle genetic effects on sex ratio were apparent in the LSS offspring, the RERF researchers excluded them from the study because they did not accord with their notions of the expected direction of such an effect [Padmanabhan, 1997]. Neels's exclusion of the sex ratio effects resulted in the belief that the genetic effects of 10mSv in the first generation would be unmeasurable. Thus BEIR V gives the incidence of total genetic effects including chromosomal effects (unbalanced translocations and trisomies) at 6 per million offspring compared with the natural rate of 4,200. It predicts a 10mSv excess risk of 10 cases of congenital malformation in a natural rate of 25,000 per million offspring and similar vanishingly small increases are given for autosomal dominant, X-linked and recessive disorders. Using a combination of mouse studies and the epidemiology of the LSS, the doubling dose for spontaneous genetic burden has been estimated to be 1 Sievert. [e.g.BEIR V, 1990 p 70]

However, the development of molecular techniques has enabled objective measurements of the consequences of irradiation to be investigated in human populations. There have been several studies of minisatellite DNA mutation in children living in parts of the ex-Soviet Union and exposed to radiation from Chernobyl. Using the technological development of 'DNA testing' in which minisatellite DNA is separated into bands which are characteristic of its genetic identity, it has been possible to show that children living in Belarus and exposed to radiation from fission-product isotopes and particle fission fragments which contaminated their environment suffered a doubling in genetic mutation. [Dubrova, 1996, 1997]. Similar work with barn swallows exposed in Belarus showed that these genetic changes were also present in these birds and were associated with phenotypic changes in their plumage patterns as well as reduced survival, therefore underlining the potential importance of such mutations. [Ellegren et al. 1997].

Most recently, the minisatellite DNA tests have been applied to the children of Chernobyl liquidators who were born after the accident compared with siblings born before the accident. [Weinberg et al. 2001] There was a seven-fold increase in genetic damage found in the post-exposure children. By comparison with mutation rates for the loci measured, this finding defined an error of between 700-fold and 2000-fold in the ICRP model for heritable genetic damage. In addition, the research results could be stratified by dose range and this resulted in a biphasic non linear response. It is remarkable that studies of the children of those exposed to external radiation at Hiroshima show little or no such effect, suggesting a fundamental difference in mechanism between the exposures. [Satoh and Kodaira, 1996]. The most likely difference is that it was the internal exposure to the Chernobyl liquidators that caused the effects.

These results follow the use of a new objective analytical method fro examining individuals who have been exposed. In this sense they cannot be subject to the arguments used against epidemiological studies. The mutations are there and are measurable so there can be little argument. The doses are known and the comparison is safe. It shows a large error in the ICRP model and raises many issues relating to the overall outcome of irradiating human populations.

I will now turn to the effects of DU.

4. The health effects of Depleted Uranium

I want to consider the DU case under four headings. They are:

- The nature and dispersion of DU and its routes for human contamination.
- Theoretical radiation biology effects and science.
- Evidence of harm at the cellular level
- Evidence of harm from epidemiology

4.1 Particle doses and hot coals

To recapitulate, the ICRP model is the presently accepted risk model for radiation and health. It is based on the idea that radiation is external to the body. Examples of external radiation exposures are medical X-rays and gamma rays from atom bombs. The ICRP model bases the amount of ill health produced by doses of radiation of different sizes on a large study of the Hiroshima survivors. These people received a very large dose and some of them were incinerated. But among those that were not, some of them developed cancer much later on. The ICRP model relates the numbers of cancer to the large dose they received and argues that at half this dose there should be half the cancers and so forth. So if the dose is very small, there are very few cancers. The problem is, that this model is not strictly applicable to internal radiation. Absorbed dose, in Grays or Sieverts or rads or rems is measured as energy per unit mass. Therefore it would not distinguish between a man warming himself in front of a fire or the same man eating a hot coal. The average energy per unit mass is the same. This a good analogy for why the DU or plutonium situation is wrongly modelled. In the case of DU particles the decay energy is all absorbed in the local cells. So one single particle will give a big dose to the local cells and no dose to the rest of the body. The ICRP will say that the dose is very small, but because the alpha decay range is small, the dose to the cells nearby, is very large. This is a trick and I show how it is done for a 2 micron diameter particle of DU trapped in the lymphatic system of a person who inhaled it.

The calculation in Table 4 shows the dose to the tissue within range of the particle alpha decays and the dose to (a) the whole body and (b) the lymphatic system that NRPB and ICRP would calculate. [see e.g. NRPB, R-276 p 86 1995) The NRPB reference is to actual calculations made by NRPB on the doses from Plutonium particles to the public near Sellafield. Two things are immediately apparent. The cells close to the particle receive a significant dose and they also suffer an enhanced risk of receiving multiple tracks. The dose calculated by the ICRP model is vanishingly small, so it is easy to see how the Royal Society, the Ministry of Defence, the United Nations, the IAEA/ WHO say that DU cannot cause any cancer.

Table 4. Doses to local tissue within range of a 2 micrometer particle of DU compared with doses calculated using the ICRP model and an NRPB version of it.

	Value	Comment
Uranium oxide U_3O_8		
Density	8.6	
Decay energy/Bq	4.45MeV = 7.12 x 10^{-13}J	
Particle diameter	2μ (2 x 10^{-4}cm)	Common size
U-238 mass in particle	3.05 x 10^{-11}g	
Particle activity	3.79 x 10^{-7} Bq	
Mass of 30μ radius sphere of tissue ($\rho = 1$)	1.13 x 10^{-10}kg	
Dose to this tissue per Bq	6.3mGy	
Equivalent dose	126mGy	
Hits to tissue per day	**0.03 α–and .06 β-tracks per day**	**11 α– tracks per year and 22β– tracks**
Equivalent dose to this tissue per day	**4.12mSv**	Or **1500mSv per year**
NRPB calculated equivalent dose to 'lymphatic system' per day	**5.8 x 10^{-11}mSv (effectively no tracks)**	*Assumes 8kg or **2.1 x 10^{-8}mSv per year**
ICRP calculated equivalent dose to 'lymphatic system' per day.	**5.8 x 10^{-10}mSv (effectively no tracks)**	**Assumes lymphatic system as 800g (ICRP) **2.1 x 10^{-7}mSv per year**
ICRP calculated dose to tracheobronchial lymph nodes per day	**3.1 x 10^{-8}mSv (effectively no tracks)**	**TBN Mass = 15g **1.1 x 10^{-5}mSv per year**

*for lymphatic system modelled as lymph nodes, liver, spleen, kidneys, pancreas, uterus, thymus, thyroid, stomach, both intestines, colon, red bone marrow and cells on bone surfaces [NRPB, 1995]

** values from ICRP standard man [ICRP23, 1975]

4.2 Borrowing radiation energy from background: second order scattering

There may be a second source of error here although it is difficult to quantify. Uranium is very dense and the particles have an enormous combined surface area. It is possible to calculate that for the smaller particles of 0.2μ diameter a 5mg inhalation loading represents some 10^{11} particles with a combined surface area of about 250cm2. Now small particles smaller than the wavelength of incident scatter incident radiation so that the particles act as secondary scatterers for the gamma rays from natural background radiation or medical X-rays or other internal emitters including other local particles. In addition, the lower energy component of this radiation, below 100keV photon energy will quantitatively be converted into photoelectrons from the particle surfaces. These are short-range highly ionising electrons which will increase the ionisation density in the immediate vicinity of the particles. This effect is increased because Uranium happens to have a very low photoelectron work function and even releases electrons when irradiated by UV and visible light so that Uranium salts are light sensitive and can be used for photography. In addition the release of photoelectrons from the particle surface will cause it to acquire an electric charge and attract negative ions which will perturb the biochemistry taking place close to the particle with unknown consequences. None of these considerations are included in the ICRP model.

4.3 Particle environmental dispersion

The military and other authorities have dismissed the possibility of widespread dispersion of DU particles. The US Department of Defense papers make this claim but have not been able to justify it. The particles of less than 2μ diameter are easily resuspended by wind or by electrostatic repulsion in the earth's electric field. In addition they become charged by photoelectric effects owing to the low Uranium work function (see above) and these charges would assist their resuspension although no experiments have been done to my knowledge. I discovered DU dust in western Kosovo one year after the war. It was in road dust at several sites under conditions where it was clear that the material had been washed out by snow. In addition the ratio of activity of the beta emitting daughter isotopes to the parent Uranium-238 showed that the U-238 was being preferentially resuspended. I gave this information to the Royal Society but their experts said that mathematical models showed that DU particles could not be resuspended and would remain where the targets were a few metres from the site of impact. I also gave a paper on this at a meeting organised in the European Parliament on DU. At this meeting I asked the head of UNEP, Dr Snihs why UNEP had not examined air filters in their November 2001 survey of Kosovo. He stated that the DU would not widely disperse and would not be found in the air so there was no need. However, I note that UNEP did deploy air measuring equipment later in Bosnia and Montenegro. This equipment detected DU in the air. The UNEP response was that the material had been resuspended by their disturbing of the soil. The UNEP Kosovo report tabulated the presence of DU in 46% of all the samples they measured but the tables were not given to the Press at the launch of the report in Geneva and the executive summary says there is no widespread dispersion of DU. If you read the report closely, their definition of widespread dispersion is of DU which would be a cause for concern in health terms, a qualification that was lost on the journalists. Here again is an example of spinning a report . Since the results tables were not given out (and have since disappeared from the report on the website) no one was able to argue the point. For those who are interested, I have a copy of the UNEP Kosovo tables and have written a critique of the whole way the results were presented. The study also showed the presence of DU particles larger than 0.2μ in a rainwater pond in Vranovac (Busby 2001).

I also found widespread DU in southern Iraq when I visited there in September 2000, or rather, I found areas of high beta counts on the ground in the area of the 'Mother of All Battles' and saw a few A10 penetrators lying on the ground also. In Iraq, I found significantly higher alpha activity in the air in this area. Unfortunately the Iraqi authorities would not let me remove any samples.

4.4 Human contamination and biokinetics

Shortly after my visit to Kosovo in January 2001, Prof Nic Priest visited the same region with BBC Scotland and took urine samples from some 20 people including his BBC cameraman. Priest has access to sophisticated mass spectrometry equipment and can measure Uranium isotope ratios in urine. He found that all the urine samples were contaminated, including the cameraman Donald Macleod who had only been there for five days. These results have now been published (Schroeder et al, 2003) and they show conclusively that the people in the area are contaminated with DU. We also have the results of measurements

on the urine of Gulf War veterans by at least three teams. All show the presence of DU in the urine some ten years after the exposure.

The only way that this could happen is that there remains in these people some depot or store of DU which is slowly leaching out. At the time of the Royal Society first report the biokinetic models of DU were based on the studies of natural Uranium in animals. It was conceded that DU particles were extremely insoluble and had a very long half life in the body after inhalation. Recent studies [Ansoborlo et al, 2001] show half lives for the inhaled ceramic U_3O_8 and UO_2 particles to be of the order of 5000 days or 13 years.

If this is so, then the amount excreted per day in the 11th year after the initial loading can be determined from an exponential decay equation such as:

$$M = M0[exp(-0.693td/T½)-exp(-0.693(td+1)/T½)$$

This gives a fraction of 0.03 of the initial loading being lost in the 11th year and a daily excretion of 8×10^{-5} (divide by 365) of the initial loading. So for an initial loading of 5mg, assuming a 10% translocation through lung and a 50% insoluble fraction there should be about 20ng a day of DU excreted in the urine if this half life is correct.

However, it is not at all clear that there may not be material that has a very much longer half life, or more likely that with such high levels of insolubility the concept off half life breaks down and there remains DU trapped in certain tissue for the lifespan of the individual which does not relate to the measured concentration in the urine. If, for example 20% of the initial translocated material were trapped in the tracheobronchial lymph nodes and entirely inaccessible to dissolution and transfer to the greater system, this would leave 100µg of DU in an organ with a mass of a few grams irradiating cells over a period of ten or more years.

We can calculate that this represents 2×10^9 particles of 0.2µ diameter, about one particle for each cell in the lymph nodes.

For even if the DU were trapped, the photoelectrons and beta or alpha particles would still cause damage to DNA in cells which were local to the trapped material.

And uncertainties in the rate equations as applied to urine measurements over the periods involved in animal studies (mice live a less than two years) would easily accommodate such a situation, so we should be cautious about using the results of urine tests to work back to initial contamination or its effects.

For 1 µ diameter DU particles biokinetic models employed by the Royal Society based on the ICRP66 human respiratory tract model suggest that 10 years after inhalation there would be a daily excretion of about 10^{-7} of the original loading but I have been unable to replicate their calculations. (Royal Society 2001).

Since levels of 20ng have been reported for UK Gulf veterans some 10 years after their contamination, the value of 5mg may be a reasonable assumption for their initial contamination on the bases of my calculations.

4.5 Chromosome aberrations in Gulf Vets

The question of the levels of exposure and the level of resultant damage has been informed by an important set of measurements of chromosome aberrations in the peripheral lymphocytes of a group of UK Gulf War veterans organised by Albrecht Schott. These results have now been published [ ]. It is possible to compare the levels of chromosome damage with the many earlier studies which related chromosome damage to earlier radiation exposure and conclude that the veterans received between 50 and 200 mSv. I have used a recent review of the relationship between chromosome damage and dose to back calculate [Hoffmann and Schmitz Feuerhake 1999] . The best value for the fraction of dicentric chromosomes (DiC) per cell per mGy obtained by regression is 5.21×10^{-5}. The Gulf veterans group showed a mean fraction of 0.0027 DiCs compared with 0.0005 in the controls. This suggests a mean dose for the group of 50mGy in the previous year which I assume must be from the 50% of the DU still in their system. For a relatively high 50mg initial loading in 1991 and 5mg getting through the lung we can calculate the mean ICRP dose to the 800g lymphatic system in the two years prior to the chromosome test.

It is vanishingly small: about 1.4×10^{-3}µGray. This suggests an enhancement of the radiation effect of about 500,000. (100,000 is the value that Tamplin calculated in 1971 for the enhancement of effects from hot particles).

On the other hand, comparisons with chromosome aberration studies of Chernobyl NPP workers who had film badges and therefore had recorded external doses [Shevchenko et al 1996] suggest more like 500mSv.

A value for particle dose effectiveness enhancement of 1000-2000 was adopted by the ECRR for their weighting factor for particulate DU enhancement in the recent 2003 report but this

may be a conservative value. Something seems to be going on here that is not adequately captured in present models and it may be that the ideas about scattering and secondary effects from background exposures need to be examined more closely. Such experiments would be easy to perform. However, these results do suggest that there should be increases in somatic genetic and heritable genetic damage and cancer in such individuals. Since the doses are mainly to the lymphatic system, some form of leukaemia or lymphoma would be the first evidence of such an effect.

4.6 Epidemiology

4.6.1 Iraq

The first reports of cancer and leukaemia came from Iraq. I was invited to the country in 2000 and met with senior health officials in Baghdad and Basrah. I examined cancer statistics from the Iraq cancer registry. There were sharp increases in leukaemia and lymphoma indicated, particularly in children born around the time of the 1991 war. The Iraqis have been accused of making up their cancer figures. However, there are pieces of data that they would not thought of making up. The main problem with cancer data epidemiology is the population base. After a war, people are killed and move about the country; there are massive population upheavals. But you can still look at the cancer numbers and assume they are a sample from an unknown population. Then you can make comparisons within the sample. For example, we can look at the numbers of cases of childhood cancer in the period 1995-1999 [Iraqi Cancer Registry, Baghdad 1999]. I show some data in Table 4 for male children (I should really say little boys) where I compare the numbers of cancer cases with those expected on the basis of the England and Wales rates for the same cancers and in Table 5 show the relative risk in the war birth cohort, those aged 5-9 in 1995-99. This calculation uses the rates in England and Wales to calculate the expected numbers of cases in each age group is the Iraq children had the same rates as the England and Wales children.

Table 4 Male childhood cancer in Iraq, 1995-1999 (Source; Iraqi cancer registry, 1999)

Cancer site	Male 0-4 Iraq, numbers England and Wales *numbers (rates)	Male5-9 Iraq, numbers England and Wales *numbers (rates)	Male10-14 Iraq, numbers England and Wales *numbers (rates)
Lymphatic Leukemia	69 69 (7.1)	112 31 (3.2)	70 25 (2.6)
Non Hodgkins lymphoma	58 58 (1.0)	82 75 (1.3)	53 75 (1.3)
Hodgkin's Disease	7 7 (0.3)	52 12 (0.5)	42 11 (1.5)
All Cancer	279 279 (19.8)	399 171 (12.2)	354 158 (11.2)

Table 5 Relative risk of leukaemia, lymphoma and all cancers in the male children born at or just after the Gulf War in Iraq.

	Observed	Expected	Relative Risk (p)
Lymphatic leukaemia	112	31	3.6 (<0.0001)
Non Hodgkins lymphoma	82	75	1.09
Hodgkins disease	52	12	4.3 (<0.0001)
All cancer	399	171	2.3 (<0.0001)

We can conclude that childhood cancer increased in the war birth cohort. The effect was driven by lymphatic leukaemia and Hodgkins disease, which is a cancer of the lymphatic system. As to the accusations of inventing the data to make a political point, there would be more

mileage in making all the leukaemia numbers large immediately after the war. In fact, this was not done, although figures for different districts show a correlation in increased in adult leukaemia with the areas where DU was mostly used.

4.6.2 The Italian Kosovo Study

The question of whether there has been an increase in leukemia/lymphoma or other cancers in occupants of or peacekeepers deployed in the Balkans has been a source of argument of a similar order and type as the question of increases in leukemia/ lymphoma and birth defects in Iraq. In the case of the Balkans, there is very little hard evidence (e.g cancer registry data) which is available for independent scrutiny, and indeed some of the problems associated with the kinds of population movements that follow a major conflict would make such analyses very difficult. There was been a leak of a table of cancer incidence in Sarajevo from the cancer registry there which suggests a more than 10-fold increase in leukemia and lymphoma even allowing for a doubling in the base population. This information was given to the Royal Society as evidence last year but was not included in their report or followed up by them [Busby 2002]. In addition , there has been anecdotal evidence of increases in leukemia/lymphoma in the Italian and Portuguese peacekeepers and these have led to misleading statements from the authorities. Recently, in a letter to Caroline Lucas, MEP, a UK government minister, Dr Lewis Moonie suggested that 42 leukemia deaths per 100,000 peacekeepers was a reasonable sum and that therefore the handful of deaths observed should be seen as a normal situation. However, Moonie should certainly know better than to try on this rather silly attempt to blind us with numbers. It was easy to show that the 42 was a ridiculously incorrect number based on people of all ages and that the true figure (based on the actual age group of 20-40) defined a significant excess risk of about 1.5 deaths in every 100,000 persons.

In January 2001, Nippon TV who took me to Kosovo were told of there were 7 leukemia deaths in Italian Kosovan peacekeepers (assume 50,000) and more recently Eddie Goncalves, a journalist in Portugal, reported 5 deaths from leukemia in the Portuguese Kosovan peacekeepers (5 deaths in 10,000 with two in the 20-30 age group).

Thus in those groups we observe 12 leukaemia deaths where 0.9 are expected, a relative risk of 13. Even if we use a two-year period since the war the Relative Risk is still 6.5.

But in May 2001 the Italians commissioned a proper epidemiological study of their peacekeepers from Kosovo and Sarajevo [Italian report, 2001]. The study of 39,491 persons found a significant excess risk from Lymphoma, particularly Hodgkins. The results are shown in Table 6.

Table 6. Expected and observed numbers of lymphoma cases in Italian DU study group with statistical significance based on cumulative Poisson probability.

Disease	Expected	Observed	Risk Ratio	Poisson p-value
Non Hodgkin	4.1	4	0.97	NS
Hodgkin	3.38	10	2.95	0.003
Lymphoma	7.48	14	1.87	0.02

I obtained this study through the Italian Greens and used the data given to calculate the true relative risk after allowing for the' healthy worker effect'. I could use the ratio of lymphoma to all cancers to show that the true excess risk was RR = 7.5. So the Italian veterans had a 7.5-fold excess of lymphoma, mainly Hodgkins disease. The interesting aspect was that the disease had emerged a very short time after the exposure, a year or two. I gave paper on this to the Ministry of Defence DUOB.

4.6.3 Cancer in the UK Gulf Veterans

The UK government have been very poor at examining the health effects of DU. But various questions have been asked in Parliament by individual MPs and the Gulf Vets themselves and non-Governmental Organisations like the Low Level Radiation Campaign have put pressure of the Ministers to investigate risk. The MoD set up a Gulf Veterans Illness Unit and these people produced a report in November 2002 which compared deaths in all Gulf Veterans compared with deaths in a matched control group who were not deployed in the Gulf. Results show that there were 19 deaths from leukemia and lymphoma combine compared with 11 in the control group.

This is a statistically significant finding (p = 0.018) but nothing was said about the finding, and my attempts to obtain a breakdown by type of cancer have so far failed.

5. The US Department of Defense.

Because this paper is about the ways in which the establishment attempt to dismiss concerns about DU I will now turn to a widely quoted report about DU in the Balkans. This is the US Department of Defense report, Depleted Uranium Environmental Surveillance in the Balkans.[US DoD, 2001]. The UK government Home Office use this report to justify their own position on repatriating refugees to areas of Kosovo where DU was used, and as a result of various appeals cases I have had to study the DoD report quite closely. I produced a critique for the Appeals Tribunal in 2002 [Busby, 2002]. The DoD document makes two assertions and bases these on 83 references, apparently to independent scientific work. The assertions are:

- The studies undertaken on DU in Kosovo have not detected any significant levels of DU.
- Studies have not shown any significant risk to health of the population of the province from the presence of DU.

As I demonstrate, here and in other papers, both of these statements are incorrect. But all I wish to observe here is that the references on which the DoD report is based are almost all references to a NATO website or other NATO reports. I show the distribution of the sources of the conclusions of the DoD report in Table 7.

Source	Number of citations in DoD
NATO website	18
NATO report AHCDU-N (2001)38, April 3rd 2001	30
NATO letter IMSM-164-01, March 5th 2001	15
Royal Society Report, May 22nd 2001	4
UNEP environmental reports, Oct 1999, May 2001	3
WHO, DU report, April 2001	6
EC Article 31 group, March 6 2001	1
Available independent relevant studies	1
Peer reviewed studies	None

Table 7 Distribution of the sources of the conclusions about DU in the Balkans: Number of citations of specific sources in the 2001 Department of Defense report on DU in the Balkans [USDoD, 2001].

My conclusions are that the position taken by the establishment is not based on science, but on wishful thinking. The NATO website and other NATO documents are reports of NATO meetings where everyone agreed that there was no problem. These positions were informed by a few meetings where military investigations agreed there were no problems. Other reports of the results of environmental surveys found no DU. This was probably because they were deploying Geiger Counters which only detect gamma rays. Later on, when there were some discoveries of DU made by the second UNEP survey, the statement 'no widespread dispersion of DU' was changed to, 'no widespread dispersion of DU at levels that would constitute a health risk'. And of course, these levels are those predicted by the ICRP risk models.

6. COMARE, NRPB.UNEP, WHO, The Royal Society, European Union Article 31 Group.

These organisations all agree with each other that there is no health consequence of exposure to DU. They have all produced reports stating this. All these reports are 'armchair' reports based on the health model of the ICRP. None of them have used scientific induction to look at the health of people who are exposed and work backwards to the exposures. Instead they look at the cancer yield in the Hiroshima survivors and say that at the doses imparted by the DU there can be no ill health. This is not science, as I argued in my first paper for the Royal Society (Busby 2000). Scientific method is based on induction. The deductive conclusion about DU and health is similar to the deductive conclusion that the Sellafield leukaemia cluster is not caused by radiation from Sellafield. Both arguments are scientifically bankrupt.

6.1 The DUOB, Department of Health and the British Ministry of Defence

In 2000, Molly Scott Cato, Richard Bramhall and I published a small book, I Don't know much about Science (Scott Cato et al 2000). In it we analysed the results of questionnaires sent to UK Members of Parliament to see what qualifications in Science they had. We also addressed the question of scientific advice to government in the immediate post Mad Cow disease period and asked how such a situation could have come about. We concluded that science advice committees were biased in the direction of Industry. Molly, who has studied politics and philosophy at Oxford suggested that the only way to allow for such bias

was to have oppositional science committees. In these structures, there are scientists from both sides of the argument, funded by government, who debate the issue within the committee and finally publish a report which draws attention to the consensus but also to the disagreements with suggestions for research that might resolve these. Shortly after this book two committees came into being where this approach was adopted (but without the funding).

These were CERRIE, which I have mentioned above and the Depleted Uranium Oversight Board.

Because the DUOB has members from all sides of the argument, from the Veterans and the Defence establishment, it is possible to ensure to a large extent that there are honest investigations of DU in the urine of the veterans.

We have tried to ensure, by elaborate mechanisms of coding and questionnaires which are photocopied and redistributed to several organisations, that there can be no James Bond exercise in which the MoD dilute the samples or alter the questionnaires.

And so at the end of this process, I believe that we can get a real understanding of the levels of DU, some ten years after the Gulf War I.

However, the Chair, David Coggon, has been able to force the question of asking the veterans who are being tested whether they have been diagnosed with cancer off the questionnaire. It was clear from the discussions that he was terrified that this question, properly answered, would enable us to analyse the samples to show that there was a significant effect.

This process has to be left to 'expert epidemiologists' which many feel means 'tame scientists' who will find nothing. This serious for us and for the veterans because we do not trust the epidemiological studies that are supposed to be happening, if indeed any happen at all.

But there is an interesting development. It seems that the DUOB may be put in charge of the whole testing and medical exercise in the Gulf War vets and perhaps also in the Gulf II veterans in which case we will able to ensure that the epidemiology is above board.

But is this does not happen, and the epidemiology is done outside the DUOB without our close inspection, then we cannot have any confidence in the results.

7. Summary: Depleted Science

So finally my conclusion. The DU story is the tip of a large iceberg, which represents the health effects of low dose radiation from man's activities in the last 100 years. Since the discovery of radioactivity the planet has been slowly filling up with radioactive material. The trend in the increase in child leukaemia since 1900 has closely followed the trend in Uranium mining and Radium production, an observation first made by Bramhall [Busby 2002].

The present cancer epidemic is a consequence of the testing in the atmosphere in the period 1959-63 of bigger and bigger atom bombs. People living in the Chernobyl affected territories, near the test sites in Kazakstan, Nevada, the South Pacific, Australia, near Sellafield and the contaminated Irish Sea, all are suffering.

And now we are seeing the health effects of these widely dispersed DU particles. It will not only be the military who are affected, it will be everyone. And the reason this has been permitted is that the health effects of internal low dose particulate radiation has been assessed by looking at high dose acute radiation from a nuclear bomb.

This is Depleted Science.

In addition, there is a cover-up of the cause of the present cancer epidemic, and the cause of cancer generally.

Cancer is an environmental disease and is increasing because of the runaway contamination of the environment by the products of industrial expansion and radioactivity from industry and the military.

If we were able to examine the rates in people who live close to contamination sources this would be apparent. But we cannot. The data exists but is kept secret.

The cancer registries are part of a huge and high level cover-up of the cause. The data would not even be released to the UK environment minister Michael Meacher, who was concerned about the effects of nuclear sites and wanted to examine the data himself. After two years of pressing for the release of small-area anonymised cancer figures, he was sacked in June 2003.

So we cannot examine this and people will continue to die.

Only last week, I was informed, to my astonishment, that the limited small area cancer mortality data that we have been buying from the UK Office of National Statistics, (and which we have used to show cancer excesses near two nuclear power stations, Hinkley Point and Bradwell) was no longer being sold to us as of September2003. This new decision, and the cover up of health data is a most serious matter which requires the attention of the Green and environmental movement and all honest people everywhere on this small green planet if we and our children are to survive.

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Environmental Pollution Resulting From the Use of Depleted Uranium Weaponry Against Iraq During 1991

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Abstract

The U.S.A. and its allies used a new generation of radiological weaponry during their aggression against Iraq in 1991. These weapons are called the Depleted Uranium Projectiles .The projectiles were manufactured for the first time in the U.S.A. from radioactive waste generated from the enrichment process of (U-238) to produce spent fuel for nuclear reactors. Practically, these weapons should be prohibited due to their destructive effects on civilians and the environmental elements for thousands of years to come.

This research has been conducted in selected areas in Southern Iraq where these weapons were used extensively by the American troops .The studied area are: Safwan City, Al-Zubair, Jabal

Sanam, Southern Rumaila Oil Fields and Northern Rumaila Oil Fields, which are all suburbs of Basrah City.

The goals of this research include measuring the increase in radioactivity in these areas through direct measurements and sampling of soil, surface and ground water, and the living tissues of plants and animals. Also, it includes the results of laboratory testing using high purity Germanium Gamma Spectrometry. The laboratory tests were all conducted in Environmental Radiological Department mof the Iraqi Atomic Energy Organization and according to (IAEA, 1981) standards method.

124 onsite exposure measurements were taken using portable scintillation counters. Also, 124 soil samples were recovered from high exposure rate areas. 58 surface and groundwater samples and 154 living tissues (from plants and animals) were also collected for laboratory tests. The sampling program was conducted after intensive studies of the geology, hydrology, geomorphology, climatology, soil conditions and radiological history of the area. It was also strongly correlated to the existence of about 13 destroyed tanks and four armored vehicles in the area.

Exposure measurements indicated the highest gamma radiation exposures in and around the areas of the destroyed targets. These measurements ranged between 9.7 – 184 μR/hr compared to natural background levels in the area of 6 – 7 μR/hr.

Throughout the whole study area, Jabal Sanam area showed the highest exposure rates. Southern and Northern Rumaila oil fields also recorded higher levels of exposure than the background levels. Sufwan and Al-Zubair areas were only slightly higher than the natural background levels due to difficulties in identifying which areas contained the destroyed artillery that had been cleared out two years before the research began.

The 124 soil samples that have been collected from 39 locations, including the destroyed targets, showed higher radiation activity than natural background levels. Depths of reclaimed soil samples ranged between 0 -30 cm. Six samples were collected from, and around, each destroyed tank or armored vehicle in the wind direction. Laboratory test results using a high-purity Germanium spectrometer showed ranges of activities of U-235 (60 – 1050 Bq/Kg) and of U-238 (measured as Th-234) ranged between 273 – 65,200 Bq/Kg. Activity ratios of 0.003 – 0.0327 prove the existence of Depleted Uranium contamination in these areas. Contamination levels and areas are site specific, measuring the highest activity within 10 m of the destroyed tank, and diminishing further from the site.

Surface and ground water sample testing showed no clear evidence of radiological contamination due to a poor exploration program and being unable to collect water samples from shallow aquifers in the area. Surface water channel sediments showed elevated activity of (2-3) folds of the natural background level in the area.

The 154 plant and animal tissues laboratory test results showed a slight increase of activity of Th-234 in four samples of widely distributed wild plants (Haloxylon Salicornicum and Stippa Capenisis) that were very close to the destroyed targets.

1.0 Introduction

During the war of 1991, the USA and its allies used a new generation of weaponry called (Depleted Uranium Projectiles) against the people and environment of Iraq. These weapons were used for the first time in history to destroy armored vehicles and civilian targets, especially in areas in the south of Iraq. Due to a lack of information about this weapon during 1991, and the following years, this research was carried out in 1995 - 1996 to define the environmental damage as a result of the use of these radioactive weapons, presented below is some information about the nature and components of these weapons.

1.1 Depleted Uranium

During the preparation of spent fuel for nuclear reactors, processing and enrichment of uranium is done to concentrate U-235 isotopes, among other uranium isotopes (U-230, U-234, U-238, U-235). The content ratios of these isotopes in the natural metal are 0.002%, 0.0058%, 99.28%, and 0.71% respectively [1]. Depleted uranium (DU) is the highly toxic and radioactive byproduct of the uranium enrichment process. It is so called "Depleted" because the content of the fissionable U-235 isotope is reduced form 0.7% to 0.2% during the enrichment process [2]. The depleted uranium is roughly 60% as radioactive as naturally occurring uranium metal, if not concentrated ; but since it is highly concentrated in the bullets , its radioactivity is a lot more than natural occurring ore and has a half-life of 4.5 billion years. Enrichment of uranium for about 50 years in the U.S.A., to be used in nuclear reactors and weapons, produced around 1.1 billion pounds of DU waste. Testing large and small caliber rounds of this weapon proved that it was highly effective

in piercing armor. Also, the Pentagon found that using DU in tank armor made them less vulnerable to penetration from conventional rounds [2]. The American army fired thousands of rounds of DU during the war. The Air Force A-10 aircraft fired approximately 940,000 (30mm) rounds of DU during combat in 1991. The weight of this penetrator is 272 gm; therefore about 564,000 pounds of depleted uranium were fired during the war [2]. Also, M1A1 tanks fired 120-mm rounds, while M1 and M60 tanks fired 105-mm rounds. The weight of the DU penetrator dart for 120-mm rounds is 10.7 pounds and for 105-mm rounds it is 8.5 pounds. 14,000 DU tank rounds were used and about 7000 rounds were fired during training in Saudi Arabia, 4000 rounds were fired during combat and 3000 were lost due to fires and other accidents. When a DU projectile strikes a hard surface, up to 70% of the penetrator oxidizes into fumes and the shell scatters into small particles. These fumes and particles can be considered a continuous source of radioactivity in these areas. Figure 1 shows different parts of a DU bullet , and Table (1) shows types of DU related weaponry in the USA army arsenal .

Table (1) Types of DU Related Weaponry That Have Been Used by USA and British Against Iraq During 1991 War

Cartridge	Caliber (mm)	Type of Weapon	DU Weight
GAU-8	30	Air Force A- 10A Thunder bolt II	300 gm
PGU-14	30	Navy Version	300 gm
M735A1	105	US Army – Tanks M1 and M60 equipped with an M68	2.2 kg
M774	105	US Army	3.4 kg
M827	120	US Army – Tanks M1 , M60 and Tanks MIA1, MIA2, "abrams"	3.1 kg
M829 (E1&E2)	120	US Army – Tanks M1 , M60 and Tanks MIA1, MIA2, "abrams"	4.0 kg
M829 (A1&A2)	120	US Army – Tanks M1 , M60 and Tanks MIA1, MIA2, "abrams"	4.9 kg
M833	105	US Army – Tanks M1 , M60 equipped by EX35-105 mm	3.7 kg
XM919	25	US Army – Bradley Fighting Vehicle	85 kg
XM900E1	105	US Army – Tanks M1,M60	10 kg
ADAM & PDM	Land Mines	US Army –155 mm howitzer	0.1 gm

2.0 Objectives of this Study

This research is a part of other ongoing researches to define the environmental pollution and damage resulting from the use of depleted uranium weaponry during the war in 1991. The major aims of the study include measuring and defining the increase in radioactivity levels through field investigation and lab tests in selected areas in southern Iraq, where these weapons were used extensively. The selected areas are Safwan, Al-Zubair, Jabal Sanam, Northern Rumaila Oil Fields, and Southern Rumaila Oil Fields. Radioactivity level measurements and concentrations should be defined in the

1-Air and soil of these areas.
2-Surface and groundwater.
3-Selected plants and some animal tissues.

Figure 2 shows the location of these areas in Iraq.

3.0 Materials and Methods

3.1 Location

The five selected locations were studied extensively to define the interference of the radioactive isotopes with the environmental pathways and their mode of dispersion. This point helps in defining the detection and the sampling program in these areas. The studied areas (Safwan, Al-Zubair, Jabal Sanam, Northern Rumaila Oil Fields, and Southern Rumaila Oil Fields) are all suburbs of Al-Basrah City and lie between longitudes (48° 00' - 47° 00') and latitudes (30° 40' - 30° 00'), see figure 2.

3.2 Climatic Condition

The climatic conditions of the area were studied to understand the directions of the transporting agents of these radioactive isotopes (wind, rainstorms, and runoff) and their pathways of spreading from destroyed tanks and targets to surrounding areas. This area is mostly part of the southern western desert with an arid and semiarid climate. Tables (2, 3 and 4) show prevailing wind directions and speed, rainfall intensity which indicate sand storm direction and frequency. Figures 3 and 4 also show dominant wind speed and sand storm directions which is mostly Northwest-Southeast towards the Arabian Gulf, Kuwait and Saudi Arabia [3].

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Table (2) Mean Monthly Rainfall Intensity in the Study Area (mm)

Year	Jan.	Feb.	**March**	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	***Total***
1990	11.2	18.125	7.3	1.6	0.25	0	0	0	0	0	3.0	0.57	42.05
1991	56.3	39.3	32.4	14.95	0.001	0	0	0	12.9	61.65	2.1	21.75	241.4
1992	19.125	10.315	29.925	4.75	0.85	0.001	0	0	0	0	36.75	28.45	130.2
1993	51	26.825	3.575	55.475	8.675	0.001	0	0	0	5.925	8.75	3.1	163.3
1994	25.1	1.125	14.3	6.325	1.375	0	0	0	0.001	18.5	38.875	27.1	132.7
1995	21.9	20.175	12.775	25.4	3.1	0.001	0	0	0.001	0	3.65	32.9	119.9

Table (3) Dominant Wind Direction in the Study Area

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1990	W/NW	NW	NW/W	NW	NW/N	NW/W	NW/W	W/NW	W/NW	NW	W	W
1991	NW	W/NW	NW/W	NW/W	NW	NW	NW	NW	NW	NW	NW	W
1992	NW	NW	NW	NW	NW/N	NW	NW	W	NW	W	W	W
1993	NW	W	NW/W	SE/NW	NW	W/NW	W/NW	NW	W	W	NW	NW
1994	W	W	W/SE	W/NW	W	W	W	W	W	NW	SE	W

Table (4) Mean Wind Speed in the Study Area (m/sec)

Year	Jan.	Feb.	**March**	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1990	2.7	3.4	4.3	4.6	5.4	6.2	5.3	5.7	4.8	3.1	2.5	2.6
1991	4.2	3.7	3.5	5.1	4.2	5.1	6.9	5.3	5.0	2.6	3.3	3.8
1992	3.3	4.1	3.4	4.2	4.3	5.8	6.9	3.7	2.6	2.4	2.6	3.3
1993	2.4	3.1	4.1	4.2	3.8	5.4	5.4	4.1	3.4	1.7	3.7	2.3
1994	3.9	3.6	3.7	3.4	4.1	5.5	5.4	5.5	2.5	2.9	4.1	3.2
Mean	3.3	3.6	3.8	4.3	4.4	5.6	5.96	4.9	3.7	2.5	3.2	3.1

3.3 Nature of the Study Area

Other related data about the area were studied from existing information and maps. Data like geology, geomorphology, topography, hydrology, hydrogeology, soil, vegetation cover, and land-use were collected and studied before starting field observation and measurements. Figures (3, 4, 5, 6, and 7) show some of this information [4], [5], [6], [7], [8], [9].

3.4 Field and Laboratory Measurements

Field observations and measurements were done through two field trips during 1996 to define radioactivity levels and point out areas of higher activity compared to natural background levels. Emphasis during detection and sampling was placed on artilleries destroyed by DU calibers, and the surrounding areas. The selection of samples from different environmental elements was conducted according to the international standards related to this subject [10]. The instruments used during this field-sampling program are listed in table 5.

Table (5) Tools and Instruments Used in Field Work

1	Polyethylene bags
2	Hand trowels
3	Auger
4	Portable scintillation counter

First, the scintillation detectors were used to define the location of higher than natural radioactivity levels, then sampling from these areas was undertaken. Figure 8 shows the distribution of samples taken from areas around the targets destroyed by DU bullets. Samples were collected from an area 10-m in diameter around each target. Other samples were collected from nearby surface water bodies. Groundwater samples were taken from existing irrigation wells. The tissues of plants and animals that are part of the food chain were also collected. Figures 9,10, 11, and 12 show the locations of the collected samples in the studied areas. Soil samples were taken from different depths and up to 0 - 30 cm.. Table (6) shows the number and type of the collected samples from the different environmental elements of the area. Table (7) shows natural background levels of U-238 and their decay series in environmental elements of the area from previous studies.

Table (6) Number and Types of the Collected Samles

1	Exposure rate measurements in air	124
2	Soil samples	124
3	Surface and groundwater samples	46
4	River and water coarse sedements	12
5	Wild plants and vegetable , and some animals tissue	154

Table (7) Natural Background Levels of Some Radioisotops in Southern Iraq { }

Type	Level of Radioactivity	
Air	6-7 μ R/R	
Soil	Th-234	---
	U-235	None
	Ra-226	50-60 Bq/Kg
Water	Ra-226	None
Water sediments	Ra-226	20-40 Bq/Kg

The preparation of samples for laboratory tests was done according to (IAEA) [10]. Lab tests were conducted using a high purity germanium analyzer in the Iraqi Atomic Energy Organization. Results of these lab tests on soil, water and living organism samples are shown in tables 8, 9, 10 and 11.

Dr. Al-Azzawi Wins 2003 Nuclear Free Futures Award

Prior to the World DU/Uranium Weapons Conference in Hamburg, Dr. Souad Al-Azzawi of Iraq was invited to Munich, Germany, on October 12th to be honored as one of the four recipients of the 2003 Nuclear-Free Future Awards. Each year, four Awards are given to individuals whose work furthers the goal of attaining a nuclear free future. A prize of € 10,000 accompanied her award. Dr. Al-Azzawi received it for her work done studying levels of radioactive contamination of soil, air, water and plants in Iraq after the Gulf War 1991. www.nuclear-free.com

Table (8) Air Rate of Exposure Readings in the Study Area

Sample No.	Exposure Rate µ R/h	Sample No.	Exposure Rate µ R/h	Sample No.	Exposure Rate µ R/h	Sample No.	Exposure Rate µ R/h	Sample No.	Exposure µ R/
S-1-1	7.9	S-1-8	7.7	SN-2-4	89.4	R-1-1	81.7	RK-2-3	51.3
S-3-1	7.6	S-1-9	7.7	SN-2-6	9.5	R-1-6	75.3	RK-2-5	98.3
SO-1-1	7.4	S-1-10	7.9	SN-2-7	9.3	R-1-7	8.4	RK-2-6	9.1
S-1-3	7.6	S-2-1	28.0	S-3-2	7.0	R-1-8	8.2	RK-2-7	8.9
SA-1-3	7.0	S-2-2	28.6	S-4-1	15.1	R-2-1	8.9	RK-3-1	42.0
SA-1-4	7.1	S-2-3	28.3	S-4-2	15.3	R-3-1	59.6	RK-3-2	43.1
SA-1-5	7.3	S-2-4	79.3	S-4-3	15.2	R-3-2	58.6	RK-3-3	42.8
SA-1-6	7.3	S-2-5	8.1	S-4-4	83.2	R-3-3	59.0	RK-3-4	92.1
SA-1-7	7.3	S-2-6	8.0	S-4-5	8.9	R-3-5	80.6	RK-3-6	9.8
SA-1-8	7.4	S-2-7	30.1	S-4-6	8.5	R-3-6	8.2	RK-3-7	9.3
SA-1-9	7.4	S-2-8	30.5	S-5-1	16.9	R-3-7	8.0	RK-4-1	43.0
SA-1-10	7.6	S-2-9	30.2	S-5-2	17.1	R-4-1	45.3	RK-4-2	43.3
S-1-4	7.3	S-2-10	82.4	S-5-3	16.3	R-4-2	46.1	RK-4-3	43.3
SA-1-11	7.2	S-2-11	8.2	S-5-4	92.1	R-4-3	43.2	RK-4-5	87.2
SA-1-12	7.5	S-2-12	8.1	S-5-5	9.3	R-4-4	78.2	RK-4-7	8.2
Z-1-2	7.1	SN-1-1	36.9	S-5-6	9.1	R-4-5	8.2	RK-4-8	8.2
Z-1-3	7.3	SN-1-2	36.8	S-6-1	14.3	R-4-6	8.2	S-7-1	49.5
Z-1-4	7.3	SN-1-3	36.9	S-6-2	14.5	RK-1-1	80.8	S-7-2	48.1
S-1-5	7.9	SN-1-4	184.5	S-6-3	14.4	RK-1-2	78.3	S-7-3	48.9
S-1-6	7.5	SN-1-7	9.4	S-6-5	75.4	RK-1-3	79.8	S-7-4	101.7
Z-1-5	7.4	SN-1-8	9.4	S-6-6	8.3	RK-1-4	152.3	S-7-7	9.5
Z-1-6	7.5	SN-1-10	9.0	S-6-7	8.2	RK-1-6	9.3	S-7-8	9.3
Z-1-7	7.6	SN-2-1	17.0	R-1-3	51.7	RK-1-7	9.0	SH-1-1	9.2
Z-1-8	7.1	SN-2-2	17.1	R-1-4	51.1	RK-2-1	51.3	SZ-1-1	10.3
S-1-7	7.8	SN-2-3	17.1	R-1-5	50.9	RK-2-2	51.9		

Table (9): Results of Soil Samples Laboratory Tests

Radionuclide Activity Conc. Bq/Kg							Radionuclide Activity Conc. Bq/Kg					
Sample Symbol	U-235	Th-234	U235 /U238	Bi-214	Pb-214		Sample Symbol	U-235	Th-234	U235 /U238	Bi-214	Pb-214
S-1-1	ND	ND	/	60.8	57.1		S-5-1	170	12150	0.0139	81.1	80.7
S-3-1	ND	ND	/	42.9	42.3		S-5-2	102	10910	0.0093	60.3	65.1
SO-1-1	ND	ND	/	36.2	31.8		S-5-3	79	7310	0.010	59.1	59.8
S-1-1	ND	ND	/	45.1	42.3		S-5-5	12	1812	0.0066	45.1	45.7
SA-1-3	ND	ND	/	32.5	39.7		S-5-6	ND	ND	/	31	39.1
SA-1-4	ND	ND	/	32.3	39.7		S-6-1	70	3325	0.020	60.9	58.1
SA-1-5	ND	ND	/	63.1	61.3		S-6-2	36.3	2019	0.017	60.1	57.2
SA-1-6	ND	ND	/	52.0	59.8		S-6-3	36.9	2100	0.0175	57.3	50.3
SA-1-7	ND	ND	/	49.1	51.1		S-6-6	4	720	0.0055	27.1	29.3
SA-1-8	ND	ND	/	49.1	51.1		S-6-7	ND	ND	/	39.2	37.3
SA-1-9	ND	ND	/	35.1	33.7		R-1-3	198	12700	0.0155	40.3	39.1
SA-1-10	ND	ND	/	31.7	39.5		R-1-4	83.1	3000	0.027	47	46.2
S-1-4	ND	ND	/	31.5	32.9		R-1-5	78.1	4950	0.0157	52.6	40.6
SA-1-11	ND	ND	/	50.1	49.3		R-1-6	375	27800	0.0138	ND	41.6
SA-1-12	ND	ND	/	29.1	28.1		R-1-7	ND	ND	/	59.3	54.6
Z-1-2	ND	ND	/	31.7	33.9		R-1-8	ND	ND	/	40.4	49.6
Z-1-3	ND	ND	/	30.3	29.2		R-2-1	ND	ND	/	39.1	35.3
Z-1-4	ND	ND	/	29.5	30.1		R-3-1	1050	63700	0.016	41.7	48.9
S-1-5	ND	ND	/	39.2	43.7		R-3-2	119	7940	0.014	44.9	42.8
S-1-6	ND	ND	/	45.6	51.8		R-3-3	1079	65200	0.016	54.9	60.2
Z-1-5	ND	ND	/	32.7	35.6		R-3-5	43	3170	0.0135	35.4	44.9
Z-1-6	ND	ND	/	38.7	40.4		R-3-6	4.1	237	0.0172	45.7	45.0
Z-1-7	ND	ND	/	32.7	35.6		R-3-7	ND	ND	/	52.5	46,2
Z-1-8	ND	ND	/	37.3	39.1		R-4-1	202	14660	0.0137	54.9	53.6
S-1-7	ND	ND	/	30.1	27.5		R-4-2	112	10300	0.0108	51.3	52.9
S-1-8	ND	ND	/	22.3	20.5		R-4-3	70.3	9700	0.0072	45.9	43.1
S-1-9	ND	ND	/	29.6	28.2		R-4-5	12.1	6500	0.0018	41.1	42.7
S-1-10	ND	ND	/	35.7	33.0		R-4-6	ND	ND	/	40.1	41.3
S-2-1	78.3	5210	0.0149	65.1	62.3		RK-1-1	901	55700	0.0161	50.8	53.4
S-2-2	41.9	3918	0.01062	57.3	59.8		RK-1-2	937	42100	0.022	52.7	50.4
S-2-3	30.3	2720	0.011	49.5	51.7		RK-1-3	488	21100	0.023	36.7	34.9
S-2-5	5.2	589	0.0088	33.9	30.1		RK-1-6	10.23	633	0.016	30.2	39.7
S-2-6	ND	ND	/	27.6	22.8		RK-1-7	ND	ND	/	52.1	50.1
S-2-7	109	9340	0.0116	89.3	90.7		RK-2-1	531	40900	0.013	60.1	51.9
S-2-8	88	7516	0.0117	77.8	81.2		RK-2-2	212	23300	0.009	58.0	55.3
S-2-9	57.1	4401	0.0129	59.6	62.1		RK-2-3	81	11800	0.006	49.3	50.1
S-2-11	10.6	916	0.0115	40.1	38.3		RK-2-6	7.1	950	0.007	44.8	40.1
S-2-12	ND	ND	/	31.3	27.9		RK-2-7	ND	ND	/	31.5	31.9
SN-1-1	60	1830	0.0327	44.3	35.9		RK-3-1	412	37350	0.011	58.3	57.3
SN-1-2	183	11400	0.167	56.3	49.3		RK-3-2	198	21700	0.009	56.1	51.5
SN-1-3	169	856	0.197	34.5	36.4		RK-3-3	73	9125	0.008	50.0	52.1
SN-1-7	5	417	0.0119	38.7	32.5		RK-3-6	6.9	812	0.008	38.3	35.9
SN-1-8	ND	ND	/	49.4	46.2		RK-3-7	ND	ND	/	33.3	31.5
SN-1-10	ND	ND	/	123	49.5		RK-4-1	229	31600	0.007	62.3	61.5
SN-2-1	74	4870	0.0152	81.6	90.2		RK-4-2	115	23010	0.0049	50.1	50.3
SN-2-2	23.8	2170	0.0196	82.9	89.3		RK-4-3	60	13200	0.0045	50.7	47.3
SN-2-3	47.3	2550	0.0185	97.4	111		RK-4-7	3.2	512	0.0062	42.1	42.3
SN-2-6	118	6810	0.0173	124	129		RK-4-8	ND	ND	/	21.9	27.3
SN-2-7	12.6	514	0.0245	95.4	90.3		S-7-1	86.3	6010	0.0143	44.9	47.1
S-3-2	ND	ND	/	44.4	31.8		S-7-2	25.1	3120	0.008	41.3	40.0
S-4-1	65	4100	0.0158	51.1	60.0		S-7-3	8.3	2120	0.003	41.9	39.9
S-4-2	30.9	3408	0.009	41.7	49.5		S-7-7	ND	ND	/	35.7	37.8
S-4-3	31.8	3115	0.0064	42.1	42.3		S-7-8	ND	ND	/	31.3	32.8
S-4-5	20.1	1070	0.018	39.8	40.5		SH-1-1	ND	ND	/	75.6	63.2
S-4-6	ND	ND	/	29.1	28.3		SZ-1-1	ND	ND	/	34.9	36.3

Table (10) Activity Conc. of Radionuclides in Water and Water Sediments

SYMBOL	Ra-226	Bi-214	Pb-214
S1	81.6	175	62.5
	90.2	160	60.1
S2	102	207	62.7
	98	198	59.3
S3	70.6	158	148
	81.3	142	137
S4	32.5	12.4	30.2
	40.1	18.3	33.1
W1	48	114	37.7
	37	108	35.2
W2	23	47	39
	28	52	43
W3	ND	36	21.3
	ND	33	17.5
W4	ND	21	ND
	ND	18	ND
F1	ND	ND	ND
F2	ND	21	ND
F3	ND	18	ND
F4	ND	ND	ND
F5	ND	21	ND
F6	ND	18	ND
F7	ND	ND	ND
F8	ND	21	ND
F9	ND	18	ND
F10	ND	ND	ND
F11	ND	21	ND
F12	ND	18	ND
F13	ND	ND	ND
F14	ND	21	ND
F15	ND	18	ND
F16	ND	ND	ND
F17	ND	21	ND
F18	ND	18	ND
F19	ND	ND	ND
F20	ND	21	ND
F21	ND	18	ND
F22	ND	ND	ND
F23	ND	21	ND
F24	ND	18	ND
F25	ND	ND	ND
F26	ND	21	ND
F27	ND	18	ND
F28	ND	ND	ND

S: Channel Sediments Sample
F: Groundwater Sample
W: Surface Water Sample

Table (11) Concentration of Radionuclides in Plant and Animal Tissues

Symbol	Sample type	Weight (gms)	Location	Distance from target	Bq/Kg			
					Th-234	Ra-226	Bi-214	Pb-214
F1	RE	154	Outside farm		ND	ND	48	42.5
F2	Stored feed	200	Inside farm		ND	51	ND	ND
F3	Melon	120	Inside farm		ND	ND	ND	45.6
F4	Tm	102	Inside farm		ND	ND	47.5	ND
F5	Tm	650	Inside farm		ND	ND	21.8	19.2
F8	Tm	820	Inside farm		ND	ND	ND	17.3
A1	HS	186	Infront of hit site	2	ND	ND	29.8	19.1
	HS	170	By vehicle	2.5	ND	ND	22.3	19.2
	RE	180	In front of vehicle	4	ND	ND	31.3	26.9
A2	HS	169	Infront of hit site	1.5	ND	ND	51.3	44.1
	RE	185	By vehicle	1	ND	ND	39.5	28.1
T1	RE	190	Behind tank	1	ND	ND	23.1	19.2
	HS	255	Under the area hit	0	86.3	62	ND	ND
	HS	286	In front of tank	5-3	28	ND	20.2	19
T2	HS	196	Under the hit area	5-2	ND	114	54	34
	HS	200	By tank	1	ND	ND	52	31.3
	HS	182	Between tank and tower	5	ND	96	56	38
T3	RE	205	Beside tank	1	ND	ND	25.2	21.5
	SS	157	Infront of tank	0.5	ND	ND	25.1	21.6
T4	RE	189	Beside tank	2	ND	ND	42.5	48
	SS	162	Beside tank	1.5	ND	ND	25.1	19.3
T13	RE	200	Beside tank	2	ND	ND	23.3	19.5
	HS	197	In front of tank	2	ND	ND	61.1	44.6
T5	RE	180	Beside tank	1	ND	ND	59.6	48.1
	HS	157	Beside tank	1.2	ND	ND	45.1	43.2
T6	RE	177	In front of tank	2	ND	ND	48.2	44.3
	HS	161	Behind tank	1.5	ND	ND	55.5	46
F10	Tm	750	Inside farm		ND	ND	22.1	19.2
F15	Tm	700	Inside farm		ND	ND	25.6	19.6
F18	Tm	850	Inside farm		ND	ND	77.1	ND
F21	Tm	800	Inside farm		ND	ND	22.7	19.3
	Onion	250	Inside farm		ND	ND	24	37.6
F25	Tm	650	Inside farm		ND	ND	27.2	20.1
F28	Tm	760	Inside farm		ND	ND	21.2	22.3
	Onion	256	Inside farm		ND	ND	27.1	30.3
A3	SC	220	Near hit area	5-1	ND	78.3	44.5	44.6
	HS	192	Beside shell	1	ND	ND	35.1	30.5
A4	HS	180	Beside shell	1.3	ND	ND	55.1	40.6
	SC	196	Around shell	2	ND	ND	50.3	55.6
T7		258	Beside tank	0.75	ND	ND	59	19.7
		241	Beside tank	2	ND	ND	58.3	21.8
	SC	246	Around tank	2	ND	ND	60.1	33.3
T8	HS	177	In front of tank	1.5	ND	ND	24.1	18.9
T9	SP	107	Behind tank	1	ND	ND	57	41
	SC	185	Near hit area	5-1	ND	119	62	29
	RE	201	In front of tank	2	ND	ND	51.5	47.1
	SC	150	Near hit area	5-1	249	275	48.5	48.6
T10	SC	195	Around tank	2	ND	ND	47	33.1
	SP	102	In front of tank	2.2	ND	ND	57	41.1
	PS	155	Beside tank	3	ND	ND	48	19
T11	SC	160	Around tank	1-0.5	ND	ND	44	38
	SP	156	Beside tank	2	ND	ND	44	55.1
	RE	144	Behind tank	2	ND	ND	28.7	18.2
T12	SP	157	Beside tank	1.5	ND	ND	45	44.1
	RE	203	In front of tank	3	ND	ND	50.3	41
	SC	180	Around tank	1.5-0	ND	ND	66.1	60.3
S1	SS	150	On river bank		ND	ND	30	ND

(SP): Stipagrostis-plumosa
(RE): Rhaneterium Epapposum
(SC): Stipa Capensis
(Tm): Tomato
(HS): Haloxylon Salicornicum
(SS): Suaeda spp.
(PS): Plantgo spp.

4.0 Results and Discussion

4.1 Exposure Rates and Measurements

Table (8) shows the exposure rates of gamma radiation measured in the study area using a scintillation counter. About 500 of the measurements were conducted in the study area. Only 124 were recorded. Most of the recorded measurements are related to the 13 destroyed tanks and 4 armored vehicles existing in the area. Other measurements were taken from areas between the cities along the highway.

We can see that the recorded exposure readings in Table (8) are site specific, with high exposure rates correlated directly to the destroyed tanks and armored vehicles. Groups or clusters of (6 - 8) measurements were taken from and around each destroyed target (Figure 8). The highest exposure rate reading represented the target itself. The highest readings ranged between (78.6 to 184.5) μR/hr.

The other three measurements in each group were taken 0.1 m away from the destroyed target windward direction. These readings showed a decrease in the activity and ranged between (14.3 – 80) μR/hr. This decrease reached half or less of the nearby target. Measurements of (5, 10) m from the target tended to be slightly above the background level which is 7 μR/hr. Higher exposure rates within a distance of (5 – 8) m from the target is due to dispersion of DU particulates and contaminated soil around the destroyed sample. A graphical representation of the rate of exposure in these areas are symbols of the table indicating areas such as:

SA: Safwan Area
SN: Jabal Sanam
Z: Al-Zubair Area
R: Northern Rumaila Oil Fields
Rk: Southern Rumaila Oil Fields
S: Sites between the above area

See figures 9, 10, 11 and 12.

The general trends of the exposure or gamma activity after five years of the war show the highest measurements in Jabal Sanam area and Southern Rumaila Oil Fields, with slightly less activity in the Northern Rumaila Oil Fields area. The areas with high exposure rates are along the international highway in north Jabal Sanam and Safwan areas.

Al-Zubair and Safwan areas have been cleared of destroyed targets without using any signs to show the locations of these potentially contaminated areas. The sampling of exposure were random and not reflective of the real situation in and around these areas.

Table (12) :Correlation Between Samples, Symbols, and Site Indications

Sample Symbol	Site Indication and Symbols	Location Areas	Location Figure
SN-1-1 → SN-1-	Destroyed tanks (T1)	Jabal Sanam	9
SN-2-1 → SN-1-	Destroyed tank (T2)	Jabal Sanam	9
R-1-3 → R-1-8	Destroyed tank 7 (T7)	Northern Rumaila Oil Field	10
R-3-1 → R-3-7	Destroyed Armored Vehicle (A3)	Northern Rumaila Oil Field	10
R-4-1 → R-4-6	Destroyed Armored Vehicle (A4)	Northern Rumaila Oil Field	10
RK-1-1 → RK-1-7	Destroyed tank (T9)	Southern Rumaila Oil Field	11
RK-2-1 → RK-2-7	Destroyed Tank (T10)	Southern Rumaila Oil Fields	11
RK-3-1 → RK-3-7	Destroyed Tank (T11)	Southern Rumaila Oil Fields	11
RK-4-1 → RK-4-8	Destroyed Tank (T12)	Southern Rumaila Oil Fields	11
SA-1-1 → SA-1-10	Random Measurement	Safwan Area	9
Z-1-1 → Z-1-8	Random Measurement	Zubair Area	12
S-1-1 → S-1-10	Random Measurement	Farms between Safwan, Jabal Sanam and Al Zubair	
S-2-1 → S-2-6	Destroyed Armored Vehicle (A1)	North Jabal Sanam	9
S-2-7 → S-2-12	Destroyed Tank (T13)	North Jabal Sanam	9
S-4-1 → S-4-6	Destroyed Tank (T4)	NW Jabal Sanam	9
S-5-1 → S-5-6	Destroyed Tank (T5)	North Safwan Area	9
S-6-1 → S-6-6	Destroyed (T6)	North Safwan Area	9
S-7-1 → S-7-8	Armored Vehicle (A2)	Jabal Sanam	9

4.2 Soil Laboratory Testing Results

Table 9 shows results of soil tests using a high purity Germanium detector, of Tennele type (USA) with a system efficiency of 40%, calibrated with Eu152, with a Canberra (8100) multichannel data analyzer. All soil samples were prepared according to (IAEA, 1981) in the Iraqi Atomic Agency's environmental laboratories. Out of the 124 soil samples taken, 64 samples contained significant to high-activity concentrates f U-235 and Th-234. From the activity concentration results of U-235 and U-238 (measured as Th-234) we notice a high correlation between these measurements (Bq/Kg) and exposure measurements (μR/hr) in the same locations.

Activity concentrations of U-235 increased in the destroyed targets' areas and decreased further away from them. The soil sampling scheme around each target is represented in Figure 8. These soil samples were taken in front of each destroyed target in the prevailing wind direction, at different depths. Along this line, soil samples were taken from depths of 0 – 5 cm, 5 – 15 cm, and 15 – 30 cm. Another sample was taken 5 m away from the target and in the same direction from a depth of 0 – 15 cm. Other samples were taken 10 m from the target at a depth 0 – 15 cm

also. Soil samples from inside the destroyed target were also collected, such as the dust and sand of the desert sand storms in the region.

As we can see, there were no detection levels of U-235 from soil samples of Al-Zubair and Safwan areas. This is mainly because the team could not locate the exact locations of destroyed targets after they had been removed and the samples in these areas were collected randomly to check any general trend of contamination.

Other soil samples close to destroyed targets showed significant activity of U-235, especially those samples taken at a depth of 0 – 5 cm (surface soil). Values of activity ranged between 60 – 1050 Bq/Kg. Measurements of soil samples from a depth 5 – 15 cm showed less activity and concentration, compared to the surface soil samples. This proves that mobility of DU is very slow in soil, where in about 5 years, less than half the activity of the U-235 in surface soil is recorded.

Soil samples from depths of 15 – 30 cm measured less activity. Samples of this depth showed 10 – 25% of the activity of surface layer samples. Some exceptions were noticed in locations of destroyed tanks (T5, A3, T1) where the subsurface soil activities indicated higher rates compared to other same-depth readings. This could be attributed to high porosity desert sandy soil with high infiltration and percolation rates.

Soil samples 5 m away from targets showed less activity concentrations which indicates that the spreading, scattering and deposition of U-235 or the DU particulates, or oxides, were limited to a diameter of 10 -15 m away from the target. Ranges of U-235 activity readings 10 m away from destroyed targets ranged from non-detectable levels to 12.2 Bq/Kg.

Soil samples from inside the destroyed tanks showed mild to high activity concentrations of U-235.

Results of Th-234 activity concentration ranges of 273 – 65,200 Bq/Kg were used mainly to determine the U-235/U-238 activity ratio. This ratio is important to decide if the activity is from natural Uranium and its isotopes or depleted Uranium. The ratio of mass concentration of U-235/U-238 in DU is less than 0.20. The natural activity ratio of U-235/U-238 is about 0.046 [11], where in DU this activity ratio of 0.2% enrichment is about 0.013.

Ratios of U-235/U-238 of soil samples from the study area ranged between 0.003 – 0.0327, with 50 samples having a U-235/U-238 activity ratio of less than 0.013. This proves that this radiological activity has resulted from the use and existence of DU in the studied soil samples. DU samples recorded U-235/U-238 activity ratios more than 0.013- see Table (9).

Activity measurements of Bi-214 and Pb-214 were used as indications of natural U-238 radioactivity in the area. These measurements were also used in helping to differentiate U-235 from Ra-226 since they have the same peak intensity of 186 KeV in the spectrometric gamma analysis that was used in this work. Natural U-238 is in an equilibrium status with its daughter radionuclides, while DU is not. [ ]

4.3 Water Laboratory Test Results

Surface water samples were collected from channels slightly further away from the destroyed targets, thus no increase in radioactivity was detected in surface and ground water samples. Groundwater samples were also collected from existing deep wells that penetrate confined aquifers. None of the groundwater samples could be taken from shallow aquifers in the area. The groundwater test results showed no detected concentrations of U-238 and its decay isotopes. Sediments from surface water channels like Khor-Al-Zubair and some surface water impoundment at Jabal Sanam and Northern Rumaila Oilfields, though, indicated higher concentrations of U-235 and Ra-226. Tested samples of these sediments recorded U-235 and Ra-226 concentrations of 102 Bq/Kg and 90 Bq/Kg in Khor-Al-Zubair and Jabal Sanam respectively. The natural background levels of this isotope in sediments of such channels are ND and (30 – 40) Bq/Kg [6].

4.4 Laboratory Test Results of Biotic Samples

A total of 154 biotic samples were collected from the study area (wild plants, vegetables, meat, fish). Wild plant samples were specifically reclaimed from areas close to destroyed tanks and armored vehicles. Other samples came from farms outside the cities' centers.

Table (11) shows the results of laboratory radiological testing using HPGe gamma spectrometry. Only four wild plant samples showed higher concentrations of Th-238. These plants are Haloxylon Salicornicum and Stipa Capenisis. The increase in activity ranged between 28 – 249 ± 30 Bq/Kg, compared to non-detectable in other samples or biotic background levels. The origins

of these samples were close to destroyed tanks and armored vehicles (T1, T2, A3, T9) in Jabal Sanam and Northern Rumaila Oil Field respectively. Importance of this finding is represented by the fact that this widely distributed vegetation cover constitutes the major food of livestock in the study area. This is one source of contamination through the food chain to the human population in the area.

5.0 Conclusions

From radiological exposure measurements, sampling and laboratory testing programs, the following conclusions were made:

1 High exposure rates of gamma radiation were detected in the areas of destroyed tanks and armored vehicles. The increase in the exposure-rates ranged between 8 – 184 µR/hr. The background exposure level in the study area is 6 – 7 µR/hr.

2 An increase of exposure is site specific and strongly correlated to targets destroyed by DU weapons in the study area.

3 Maximum exposure rates were recorded from the destroyed targets. The following high rates were recorded at a distance of 0.10 m from the target. Exposure rates close to natural background levels were detected 10 m away from the targets.

4 The highest exposure rates were recorded in the Jabal Sanam area, Southern Rumaila Oil Fields and Northern Rumaila Oil Fields in that order. Safwan and Al-Zubair measurements indicated slight increases of exposure in correlation to background levels. Destroyed artilleries were removed from these areas without any signs or indicators of where they had been. The limited exploration and sampling program is the major cause of poor detection in these areas.

5 Soil sample laboratory tests proved high activity concentrations of U-235 and U-238 measured as Th-234. Activity concentration measurements of U-235 in soil samples from contaminated areas of destroyed tanks and vehicles ranged from 60 – 1050 Bq/Kg. For Th-234, the range was 237 – 65,200 Bq/Kg.

6 The increase of activity concentrations are site-specific and highly correlated to the 17 destroyed targets by DU weapons in the studied area.

7 The highest activity concentrations were measured from soil samples 0.1 m away from the targets. Surface soil recorded higher U-235, U-238 activity levels than samples from 5 – 15, or 15 – 30 cm deep. High activity levels were also recorded for soil or dust reclaimed from inside the tanks.

8 Activity measurements from soil samples 10 m away from the destroyed targets are close to original background levels and tend to diminish further away from the target.

9 The activity concentration ratios of U-235/U-238 range between 0.003 – 0.0327 which are less than 0.046. This proves that this activity results from DU radioisotopes and not from natural radiation activity.

10 Contaminated soil samples are mainly from Jabal Sanam, Southern Rumaila Oil Fields and Northern Rumaila Oil Fields. Al-Zubair and Safwan soil samples showed no significant increase in activity due to the limited exploration and sampling program of this study.

11 No radiological activity could be detected in surface and ground water samples collected from the area. Sediments from channels and wadies in the area showed 2 – 3 fold increase in radioactivity.

12 High Th-234 activity concentrations were detected in four samples of wild plants (Haloxylon Salicornicum and Stippa Capenisis) that were close to one of the destroyed tanks in Jabal Sanam and the Southern Rumaila Oil Fields.

13 Most of the plant samples have certain levels of activity concentrations of Bi-214 and Pb-214 which indicate the natural background levels of U-238 in these plants.

6.0 Recommendations for Further Research:

1. Since the testing of this study was conducted during 1996, and maximum environmental and health damage were expected to have occurred during the events of the war in 1991, further reverse analysis and modeling are going on to simulate the collective dose the people of Basrah City and it's suburbs were exposed to during 1991.

2. Continuous monitoring and measurement are necessary to specify other contaminated areas where the destroyed targets have been pulled

out of the area. This testing is also necessary to check the radiological contamination among the troops and army personnel.

3. More research is needed to simulated the spread of these pollutants since 1991 by wind, water, groundwater, and throug h the food chain in order to calculate all the living and nonliving environmental damage contaminated by DU weaponry.

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Audio presentations can be heard at: http://www.traprockpeace.org/depleted_uranium_hamburg03.html

Ladies and Gentlemen, I have the honor to talk to you about the effects of the impact of depleted uranium (DU) on the people in the south of Iraq.

I am Dr. Jawad Al-Ali. I am consultant physician, and I am the head of Department of Medicine at the Teaching Hospital of Basrah; and at the same time I am the manager of the Cancer Treatment Center in Basrah, which provides treatment for the three southern districts of Iraq.

First slide: This is my hospital where the Cancer Treatment Center is located. And this hospital has a history in the [1991] War. It is totally damaged by at least 12 missiles during the War; two of them falling in the garden of the hospital, and it killed 4 of our patients, and it destroyed the whole hospital – the windows, the doors, and the lifts. And since then until now I have 13 patients of the staff who work in the hospital at that time. They got cancer; 8 of them are doctors and the rest are from the paramedical staff.

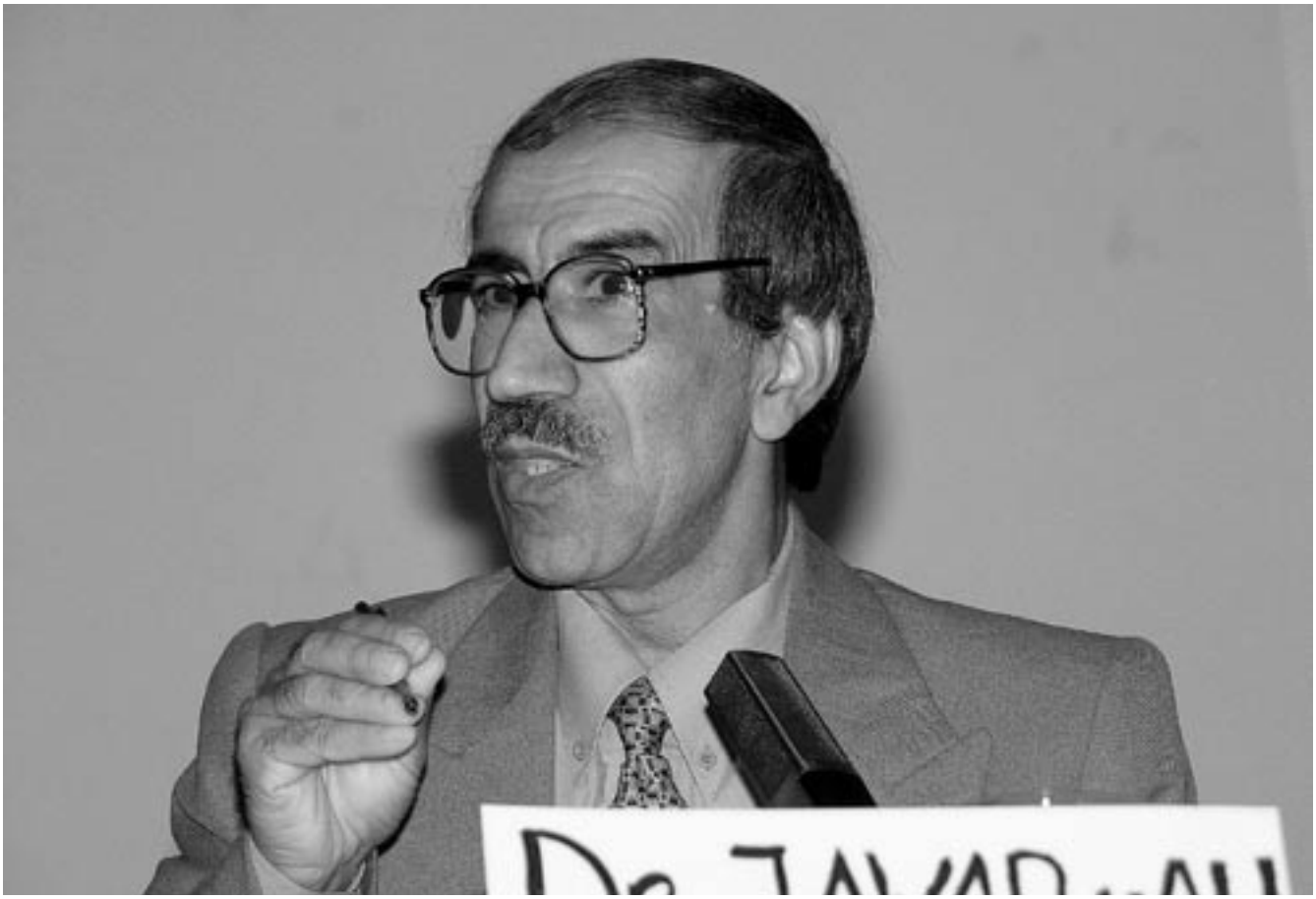
Next slide please: It is estimated that 800 tons of DU is delivered over the wholes area of Iraq, and at least 300 tons to the western parts of Basrah.

Next one please: And the level of radiation has been studied by the engineering department, the environmental engineering department of the College of Engineering, the University of Baghdad, was 10 times more in the air, and about 10-5,000 times in the soil.

Next one please: This is the map of Iraq and this is city of Basrah, the red one. And these are the two cities of the north, and here is Kuwait and Saudi Arabia and Iraq and Iran. And this is the area where most of the people are contaminated; 45% of the people in the area are at risk of getting cancer from radiation.

Next one please: What are the health consequences due to DU which we noticed in Basrah? We have an increase incidence of cancers, and increased incidence of congenital malformations and abortions, and we have appearance of diseases of unknown etiology, possibly due to toxicity with DU, and these are the muscle diseases, neuropathies -- that is nerve disease,-- and kidney failure and diseases like the bloody diarrhea, which is mentioned yesterday (Oct. 16). And I

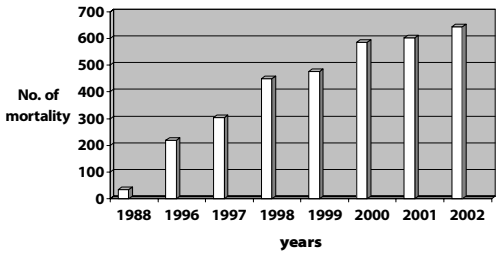
Dr. Jawad Al-Ali, Iraq



noticed also as a physician that we have an increased number of patients who suffer of "wheezy chest," and this is possible due to fibrosis of the lungs.

Again we have "strange phenomena," which appear after the 1991 War. These phenomena, one of them is the clustering of cancer, of familial cancer. We collected many families and now have 58 families with more than one member in the family affected by cancer. And one of the families we have 8-10 patients in the same family with cancer. And the other phenomenon is the appearance of double cancer – a patient with 2 cancers at the same time. And just a month ago, or more than a month, I got a patient with three cancers -- cancer of the stomach, cancer of the kidney, right; and now we discovered another cancer in the left kidney. The cancer mortality also is studied, and it's increased more than 19-fold within12 years.

CANCER MORTALITY IN BASRA AFTER 1991COMPARED WITH THE YEAR 1988



Next one please: This is the incidence of cancer compared with the 1988, that is, before the War, and as you see, this is from local registry in Basrah. And in 2002 the last year it was 123 patients for each 100,000 of the population. And this means that we have more than 10 times the increase in the incidence within 10 years. This figure, if we compare to the WHO figure, it is 2-½ times the WHO figure, as far as I know is 52 per 100,000. So this is 2-½ times the WHO figure, and is significant.

THE INCIDENCE OF CANCERS IN BASRAH AFTER 1991

THE YEAR	CANCER INCIDENCE
1988	11/100000
1998	75/100000
2001	116/100000
2002	123/100000

Next one please: This is the, this graph shows the mortality. Also we compared 2002 with the year 1988, and in this year we had 34 patients who only died because of cancer while in 2002 we had 644 patients died because of cancer. Of course our registration is underestimated. We are not registering all the patients; even this mortality is lower than what we expect, at least 20-25% of the patients are not registered. They died because of something else.

Next one please: "Strange phenomena," and cancer, we have as I said, clustering of cancer in families and we have 58 families until now, those under my care. Possibly there are more under the care of other doctors. Double cancers in 9 patients, triple cancer in one patient, and also we have a change in the pattern of cancer. The cancers, which are seen in elderly people now, we see them in a very young age groups.

Next one please: This is a study done by Dr. Al-Ani, and I shared in this study. In this table you can see patients who are all soldiers and they are some of them are exposed, and some of them are not exposed, and this is the odd ratio which is very significant for lymphoma, leukaemias, brain cancer and bone cancer and as a whole also it is significant.

ODDS RATIOS OF 1291 CANCER CASES IN THE SOUTH OF IRAQ WHO WERE EXPOSED TO D.U. CONTAMINATION, COMPARED WITH 321 PATIENTS WHO WERE NOT EXPOSED TO D.U.

Malignant D.U. weapons effects after Gulf War 1991 with Odds Ratios.

Dr. Al-Ani and Jawad Al-Ali, MRCP (UK).

	Exposed		Unexposed		Odds Ratio
Malignancy	Cases	Controls	Cases	Controls	
Lymphoma	449	634	44	351	5.6
Leukemia	311	573	48	429	4.9
Brain Cancer	162	183	23	114	4.4
Liver Cancer	36	46	36	97	2.1
Bone Cancer	57	91	27	87	2.0
G.I. Cancer	66	125	65	177	1.4
Lung Cancer	210	627	78	357	1.4
Total Cases	1291	2279	321	1612	2.8

An Odds Ratio of 1.0 means "no effect".

Editors Note: The original chart had been reviewed by Dr. Ross Wilcock, who found computational errors, and submitted these to Dr. Jawad Al-Ali. This is the recalculated chart.

Next one please: This is distribution of 5 common cancers - that is, their prevalence per-100,000 of population in different parts of Basrah, 5 common cancers. You can see here the most prevalent cancer and in the center of the city Basrah is breast cancer, then comes next lymphomas and leukaemias, while in Zubair, the area is very near to the battlefield, we have cancer of the lung, which is expected to have more cancer of the lung in this area. While in Qurma, that is in northern

part of Basrah, we have leukemias more, and also you can see lymphoma, is again it's high. And in Fao, that is the southern part on the Gulf, we have cancer of the gastro-intestinal tract (GIT), is more, and this I explain it because of the heavy shelling of the area by traditional bombs during the Iranian War, and the TNT in the bombs might cause gastro-intestinal, especially stomach cancer. That's why we have more cancers of the GIT there.

DISTRIBUTION OF 5 COMMON CANCERS / 100000 OF POPULATION IN DIFFERENT PARTS OF BASRAH AFTER GULF WAR 2

CITY	Ca. Breast	Leukaemias	Ca. lung	GIT-Cancers	Lymphomas
BASRAH	**40.3**	19.7	9.3	14.4	**20.8**
ZUBAIR	23.8	14.6	**12.3**	10.8	11.6
QURNA	13.5	**20.0**	3.2	14.8	13.5
ABULKHASEEB	27.4	8.9	8.2	8.9	15.6
MDAYNA	14.1	9.4	5.5	10.2	6.3
SHAT-ALARAB	14.1	10.6	5.9	11.8	17.6
FAO	31.2	6.3	12.5	**18.8**	12.5

Dr. Jawad Al-Ali

Next one please: The evidences to blame DU as a cause for these diseases after the Gulf War 2 (1991). First of all, we have increased levels of radiation in the area. And this is studied after the War, and we have an increased incidence of cancers, increased rate of mortality, according to many studies; and increased rate of congenital malformations. The types of cancers and their incubation periods are closely related to radiation, as leukemias. We found that leukemias at year 3-4 years after the War, while the bone cancer and soft tissue cancers appears now. And then we have the "strange phenomenon" – double familial and triple cancers -- are not seen before the War. I have not seen, I worked in Base for 34 years and I haven't seen these phenomenon.

Most of leukaemic children were born to fathers who were involved in the Gulf War, and, I think Dr. Jenan (Hassan) spoke about this. The only cancer inducing factor, which is a new after the Gulf War is the radiation factor. We have all the factors which induce cancer – from smoking or diet or infection – but we haven't got increased incidence before the War. And the only factor, which has been changed is the radiation factor, which is due to depleted uranium. To strengthen the evidence is cytogenetic, cytochemistry, and documentation of uranium in the tissues or fluids of patients are needed.

Next one please: And now we have shown some pictures, quickly.

Next one: These are government complex, there is nothing in this complex, and it is destroyed now in this War, the new war.

Next one please: Again this is the Party building, it is destroyed for nothing also.

Next one please: These are my patients. This is child of two years, with a non-Hodgkin lymphoma, which is not seen usually at this age. It's a disease of elderly people. This child died after referring her to Dr. Jenan for treatment on the same day.

Next one please: Again, this is a child with, you see his testicle is swollen, and he got an ass in his abdomen. And Dr. Jenan knows about his story. He died also in the Pediatric Hospital. This is three years old.

Next one please: This is 13 years old child who died after a few months because of lack of medicines. And you see it's an advanced case of non-Hodgkin lymphoma.

Next one please: Again this is a child of 14 years, and he got a big bone, a big swelling head due to bone cancer, and I think this is beyond treatment; he will not be cured; still alive, I wish I could help him a lot.

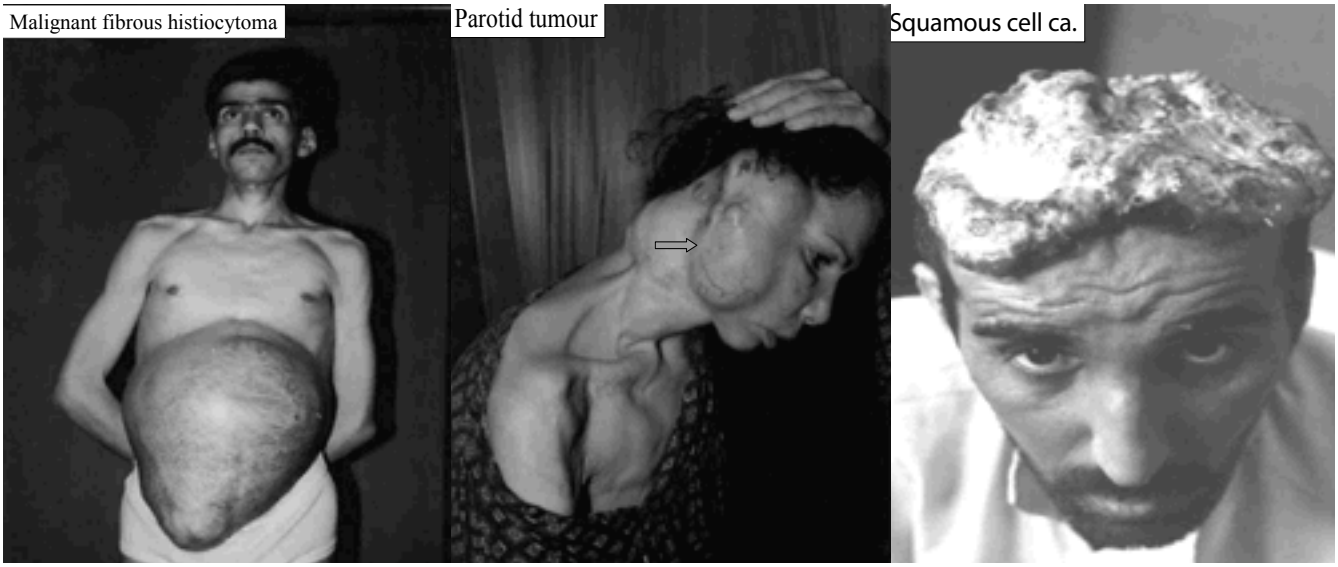
Next one please: Again, this is a teacher with a muscle tumor, and the tumor is spread to the liver and to the lungs, to die after a few weeks.

Next one please: Again, this is a lady with a bone cancer spread to the chest, inside the chest and you see the mass, it could be seen from the outside. And I think she will die after a few weeks.

Next one please: This is again a girl of 17 years with a bone cancer.

Next one please: Again, this is the biggest tumor which I saw. This is called malignant fibrous histiocytoma, which is closely related to radiation. And it is, in the literature, it's recorded, very few cases are recorded. No more cases of this, but, I recorded about 20 patients of malignant fibrous histiocytoma.

Next one please: Again, this is a military man, and he works in the navy, and he got a malignant fibrous histiocytoma and he received his first dose just two weeks ago of chemotherapy, two weeks ago, and you see, he's laughing, he doesn't know what's in the future. Yeah.



Next one please: Again, this is 12 years old child with a big mass in the abdomen, and you see this is non-Hodgkin lymphoma with infiltration of the breast. The other breast is normal. I give her the first dose just a week ago, before my travel.

Again, next: This is an acute myeloid leukemia which is related to DU or radiation effects, and you see the bleeding site. I think this patient will not survive more than 6 months.

Next one please: Again, this is a very big tumor, again malignant fibrous histiocytoma, yeah. So this is closely related to radiation.

Next one please: Again, this is parotid tumor. Multiple operations are done to remove the tumor, but it recurred again and again.

Next one please: Again, this is a man who is living at the borders between Iraq and Kuwait in Saffwon, and this man has got an injured head; he got a wound and possibly it is contaminated by DU particles. To have a big tumor infiltrating the skull, down to the brain. And he died within one month.

Next one please: Again, this is a soldier with a big abdominal tumor, and he died one month after admission to hospital.

Next one please: Again, this a elderly lady. See how big the tumor is – a non-Hodgkin lymphoma with compression of the veins inside the chest.

Next one please: These are congenital malformations.

Thank you very much.

(Applause)

There is a Dr. Al- Ali video with his PowerPoint presentation from the Conference done by Dr. Ross Wilcock, which can be seen over the Internet with the Real One or Windows Media (9 support) Player:

http://Effects of DU War in Iraq
or try
mms://216.138.195.197/Effects of DU War in Iraq

The link is also at:
www.uraniumweaponsconference.de

Oncology Center, Basrah

Dr. Jenan Hassan, Iraq

IRAQ WORLD DU/UW CONFERENCE,
HAMBURG GERMANY 17 OCTOBER 2003

Ladies and Gentlemen, good morning. I will present what happened in my country after Gulf War [of 1991]. And I call this, my research, is the further evidence of the relation between the depleted uranium [DU] and the incidence of cancer and congenital malformation among children in Basrah City.

A part introduction, in 1991 the American troops xxxx unleashed their aggression against Iraq used weapons containing depleted uranium-238, and this has been confirmed by detecting high radioactivity using gamma spectrometer analysis of plant, water and soil samples taken from Basrah governate south of Iraq, as Dr. Souad [Al-Azzawi] spoke before. Papers published from the West did not deny this fact. The relationships between the exposure to ionizing radiation and cancer has been documented in various studies in other parts of the World: apart from the survivors of the atomic bombs at Hiroshima and Nagasaki, such relationships have been proved among uranium miners and employees of nuclear reactors in England and Canada, and those living close to Chernobyl.

(Next) The first Table show to us the incidence of malignant disease among children in Basrah before the War – 1990 – and up to 2002 in the second Table. You see that in 1990 the number of the cases is 19, and this increasing to 43 in 1997. This is new case, only a new case in Basrah City, and this incidence is underestimated. Because most of the cases maybe died at home, not reached the hospital because of poverty, or maybe go to Baghdad directly for treatment.

(Next) We see this is the leukemia, and the lymphoma brain tumor, in 1998 up to 2002. We see how the total cases increase, the new cases up to 160 in 2002.

(Next) This incidence rate of malignant disease in children as take the number of children below 15 year, we see this is the number of malignant disease. This is before the War, 1990; and this in 2002 is about 160, and we see the incidence rate per hundred-thousand, we see before the War, is 3.98. Ans this increases up to 18.5. This more than about 7-times than before the War.

(Next) This is about geographical distribution of the cases. We see most of the cases in Mdayna, and this here there is a electrical power, and during the War, this highly exposure to bombing in 1991; and in Zubair, 30.4, and we see in El-Hartha (sp?), 36.9, and in Qurrna. We see this is the most earlier, we see the cases brought from this area city in Basrah.

(Next) We see the age distribution of children. We see suffering, most of the cases suffering from cancer is children below 5 years of age is about 53 children below 5 years of age. And this indicated these children were not present at the time of the War. An explanation of this is that the parents may have been exposed to DU before the delivery of these children.

(Next) And about mortality rate of new cases of cancer among children. We take this in 2000 and 2002. We see the new cases in 2000 is 92, and in 2001 is 100 -- this is new cases -- and in 2002 is 160. We see the number of deaths as 50 in 2000, and 62 [in 2001] and 80 [in 2002], and the percentage is 54% and 62% and 50%. And this mortality is high mortality because of the economic sanctions in Iraq after the War. And this because of shortage of chemotherapy because the USA said some of the drugs introduced into chemical weapons. So they forbid it for us.

(Next) We see the mortality rate among children with leukemia. We see the most cases is leukemia, and we see the mortality in leukemia in 2000 is 58[%], 2001 is 71%, and in 2002 is 71%. How we see the increased mortality? Because there is no chemotherapy in my country.

(Next) We see this is the map of distribution of cases of cancer. As we see there is Zubair, El-Hartha, Mdayna and Shat-alarab. This is Zubair. The most cases of cancer in this area.

The lumps on the head of this boy with leukemia indicate that the disease has gone to his brain.

Child with leukaemia

At Dr. Jenan Hassan's work: Children Clinic in Basrah

(Next) We see also this is the map of the distribution of the age. We see also that Zubair is the most area with cancer.

(Next) This is about, as mentioned before, there is increase in the percentage of cancer and congenital malformation. The baby may be born with many deformities, like without head, without limbs, without eyes, or without nose. Here is the frequency of the distribution of the cases. We see this is type of malformation: mengomalicy, encephally, multiple congenital malformation, chromosome aberration, congenital heart disease, a bit of extrophy, focamelia, exciosis, cleft lip and palate, anphallousy, contraplasia, esophageal extrasia, imperferate and xxxx cornea, hydrocephalus, ulthrafibrousis, cyclo xxxx, esophageal aphasia.

We see the most important thing: we can see anencephally. Before the War is 3 cases, and this increasing up to 67 in 1990 to 2001. And multiple congenital malformation. And this baby born with many deformities – is only 7 before the War. And see this increasing -- 13 to 49 and up to 224 from 1990 up to 2000. This is high increase of this percentage.

And another thing is focamelia. Focamelia means the baby may have a shortening or absence of a limb. We see not mentioned before the War; and this increasing up to 75 cases. What happened in my country [is]happened in offspring [of] the soldiers of the USA and in Kuwait City. And this indicated there is something sharing between the three countries.

(Next) We see the incidence rate of congenital malformation regarding the number of birth. This is in one hospital in Basrah. And there are four other hospitals responsible for delivery. We see this before the War, 1990, 37 [cases] and the incidence per one-thousand births. This is the number of births in my hospital. We see 3.04 [per thousand]. This percent increase in 2002 is 22.9%. And in 2002 up to 35 as compared before the War. We see this is about more than 7 times in 2000; and more than 8 times in 2002.

(Next) This is a graph showing how the distribution of how congenital malformation is increasing up to 2001.

(Next) About conclusion. We see the corresponding rise in all malignant cases among children below 15 years is about 300 as compared before in 1990. This is in 2002, and there is 120% rise in the recorded cases of leukemia. The increased incidence of congenital anomaly in such situation is due to exposure of a pregnant woman to radiation which exceeded three thousand millirads. Evidence of paternal exposure to ionizing radiation before conception or xxxx maybe occur. Increased mortality of cancer cases among children due to the shortage of chemotherapy due to the economic sanction.

If there is cytogenic studies in our country, concentrate such evidence by allowing to estimate the absorbed radiation by using DNA probe to detect the chromosome aberration.

And then (you have photo), here are some photos of the children with cancer and congenital anomaly, and this is up to date; this if in 2001 and 2002. We see this is a baby about nine months old, with a huge abdominal tumor here.

(Next) We see this is many children with cancer in my ward, and we see the playing room. This is very small in size, but we see it is a playing room opened by the help of the Arab xxxx Society. She helped us too much, and from the Japanese people.

(Next) This chart with abdominal mass lymphoma. We see most of the cases of lymphoma in younger aged group.

(Next) This we see this is still alive, this child, with this deformity. The father is a soldier, most of the cases, the father is a soldier. Xxxx in the 1991 War. And this is all, we call this the victim of the First War. Until wait what happens in 2008. As we know the incubation period of DU is five years.

Thank you very much.

Heike Schröder, FRG

Molecular Biologist

I'd like to present the results of our chromosome aberration study that we have performed on white blood cells of 16 veterans of the [1991] Gulf War and/ or of the Balkans war. This study had recently been published in the peer-reviewed international journal 'Radiation Protection Dosimetry'.

I will also point out to the speciality of the applied chromosome aberration assay and I will start with that:

The objective of the study was to investigate veterans of the Gulf War and of the Balkans war with suspected exposure to depleted uranium for unstable chromosomal aberrations. These are dicentric chromosomes and centric ring chromosomes. They are called unstable aberrations because after a single radiation event they disappear from the blood with a biological half life of about 3.5 years. Analysis is performed on metaphase sets of peripheral blood lymphocytes by light microscopy. These T-lymphocytes are easily to be obtained by venipuncture, and culturing as well as the further processing is standardized. Dicentric chromosomes derive from two DNA double strand breaks 'aberrations' in 2 different chromosomes. As a consequence of a false repair the broken ends of the chromosome arms fuse together and build a chromosome with 2 centromers, therefore called dicentric chromosome. The cut off endpieces of both chromosomes also fuse and build an acentric fragment. Centric ring chromosomes derive from 2 DNA double strand breaks within a single chromosome. Again, the broken ends of the chromosomes are misrepaired and form a ring with one centromer. An acentric fragment does also derive. Dicentrics and centric rings are most effectively induced by ionizing radiation, and their induction results in a dose-dependent manner. Based on adequate calibration curves, this enables dose reconstruction for example, in the case of an externally applied radiation overdose.

Dic and cR are validated and reliable biomarkers that have been applied to individuals and in population studies over decades. Quantitative analysis of these aberrations is both sensitive and specific in evaluating previous exposure to ionising radiation. The method is also called "biological dosimetry" , and it is the 'gold standard ' to prove or to exclude radiation burdens that people have eventually experienced in the past.

I will now come to the study group we have investigated:

16 British veterans, 2 females and 14 males volunteered to participate in the present pilot study. All had been deployed in the Gulf War in 1990 to 1991 or/ and in the Balkans war in 1995-1996 and 1999, and all have suffered from various medical complaints since then. These mostly non-specific symptoms – such as headache, chronic fatigue, depression, muscle and joint pains, impaired short-term memory and other cognitive defects, and others - have been referred to as the 'Gulf War syndrome'.

All men and women investigated described situations during their active service which were probably associated with exposure to depleted uranium, and this exposure was probably through inhalation of uranium oxide in its aerosol form.

The method of chromosome aberration analysis cannot distinguish between different sources of radiation exposure, but shows the total whole body radiation burden of the subject under investigation. Since the specific activity of depleted uranium is known to be comparably low, precisely recording all kinds of exposure to ionizing radiation that might have affected our volunteers was essential. To cover that a measurable effect was attributed to DU and not to more than average radiation burden by other sources, the volunteers of our study were carefully selected considering the following exclusion criteria:

Previous radiotherapy and/ or medical use of toxic drugs Greater than average exposure to diagnostic medical radiation Heavy smokers (more than 20 cigarettes a day over more than 10 years Previous work in the nuclear industry or in other badge-monitored occupation.

Status with respect to these exclusion criteria and other relevant exposure, in particular to ionizing radiation, was assessed in a detailed questionnaire developed in our laboratory.

The blood samples had been taken by venipuncture in March and in December 2001, respectively, and another three blood samples had been taken in August 2002. Upon arrival at our Bremen laboratory, all samples had been coded before further processing. Processing has followed OECD normative. In brief: Lymphocyte cultures had been set up in the presence of Bromdesoxyuridine, a base analogue that enables differential staining with Fluorescence plus Giemsa to distinguish between first and further division metaphases.

The frequency of dicentric chromosomes and centric ring chromosomes has been determined in about 1000 first division metaphases per individual blood sample by light microscopy. In this study we did not have an appropriate control group comparable to the study group with respect to all the multiple warfare agents the investigated veterans had been exposed to. Therefore our own laboratory control group was chosen to evaluate the findings of the study. With a frequency of 0.5 dic and cR per 1000 metaphases our control is in accordance with other published 'historical' control values.

The mean frequency of dic and cR in the veterans' group is 2.5 per 1000 metaphases. Numerically, this indicates a 5-fold elevation among the veterans compared with the control. The difference is statistically significant and the result strongly indicates previous exposure to ionizing radiation for the group as a whole and for at least 50% of the individual members (the respective data are emphasized in the table). Stratification according to deployment did not alter the results. Using questionnaire information the highest dose from diagnostic radiation in the past for any of our volunteers would be in the range of some 5-50 mS. It therefore seems to be unlikely that this might explain the observed highly significant increase of the aberrations.

The intercellular distribution of the dic and cR indicates significant overdispersion on the group level which is due to the results of three veterans who had served in the Gulf War. Overdispersion of dic and cR is a known consequence of non-uniform irradiation, for instance partial body exposure or incorporated radionuclides, and/ or irradiation with high energy impact.

The very rare finding of a multicentric ring in a tetraploid metaphase (that is a M with a doubled chromosome set, this M was excluded from the calculations) and the finding of one metaphase with pulverized chromosome material may be considered as a further indication of high-LET radiation. We have previously observed such

pulverized chromosomes in Concorde pilots exposed to cosmic radiation that has an important contribution from high LET-radiation, and doubling of metaphase sets and pulverisation was frequently observed after in vitro treatment of blood samples with the alpha-emitting radionuclide Po-210.

Assuming a contamination due to ingested soluble oxides of depleted uranium about 10 years ago which would have been excreted with the urine within some few days, and considering the limited half-life of dicentric chromosomes of about 3.5 years following acute exposure to ionizing radiation, the hypothesis of a single acute event 10 years ago is dismissed. It would be implausible to explain the high aberration yield we have found in this pilot-study.

However, if the members of our study group had inhaled insoluble, for instance ceramic and very small-sized particles of DU, these might have been deposited and concentrated in their deeper lung and could have delivered considerable doses to the local tissue and to the lymp h nodes. Local doses from DU may then be persistent and chronic and would accumulate to considerable local doses. This scenario adds plausibility on the cytogenetic findings in the peripheral lymphocytes of the investigated veterans.

However, besides DU the veterans were exposed to a large number of different agents in unknown concentrations and mixtures on the battlefields, and therefore a confounding or synergistic effect contributing to the observed yield of dic and cR cannot not to be excluded.

I'll come to the end:

Quantitative analysis of dic and cR is both sensitive and specific in evaluating previous exposure to ionizing radiation. In the absence of

Results of the chromosome aberration analysis

Subject	Age	War of the Gulf, G Balkans, B	Number of analysed cells	Number of dicentrics and centric rings	mean frequency per cell
1	41	G	1001	4	**0,004**
2	37	G	1002	3	**0,003**
3	44	G	1001	7	**0,007**
4	41	B	1003	2	0,002
5	36	G	1001	3	**0,003**
6	42	G	1003	2	0,002
7	30	B	1002	2	0,002
8	32	G	1000	4	**0,004**
9	57	G	1005	1	0,001
10	38	G	1000	1	0,001
11	49	G	1002	2	0,002
12	34	G+B	1002	3	**0,003**
13	46	G	999	3	**0,003**
14	31	G	1001	1	0,001
15	29	G	1001	1	0,001
16	54	G	1001	3	**0,003**
17	41	G	938	0	0,000
18	40	G	1007	2	0,002
19	32	G	1001	3	**0,003**
Total			18970	47	**0,0025**
Control			45259	23	0,0005

other radioactive sources, the observed significant increase of these aberrations and their overdispersion (clustering) give strong evidence that the investigated veterans might be exposed to chronic irradiation, most probably resulting from inhaled DU particles.

Thank you for your attention.

Also see her Powerpoint presentation on the CD in this book.

Science workshop at the Conference

Prof.
Siegwart-Horst Günther, FRG

Uranium Projectiles: The Danger of Low-Level Radioactivity on Life and Environment

17 October, 2004

In 1972 the Canadian scientist A. Petkau published studies on the effect named for him. The result of his experiment show that a very small chronic dose of radiation can be one hundred to one thousand times more dangerous than the international committees for radiation protection are still assuming.

The U.S.-American John W. Gofman who was involved in the development of the atomic bomb said, „There is no excuse that I, Gofman, did not earlier sound the alarm on the activities of low, ionizing radiation. I believe that at least some hundred scientists, including me Gofman, who dealt with the biomedical aspects of atomic energy, are candidates for a trial similar to the ones in Nuremberg, as with their great carelessness and irresponsibility, they committed crimes against humanity. Now knowing the dangers of low radiation the crimes are no longer an experiment that we do, but murder."

According to the results of the examination produced by the U.S.-American citizen Ernest J. Sternglass in 1974, low radioactivity not only results in hereditary defects, cancer and leukemia, but it increases the big number of risks for health in general; it even seems to have extremely adverse effects on certain damages to the environment, e.g., the dying of the forest. With high statistical validity epidemiological studies indicate negative effects, i.e. declining intelligence, increasing crime rates, and immunodeficiency AIDS.

In 1988, during a convention of AIDS researchers the U.S.-American citizen P.H. Duesberg, one of the most acknowledged molecular biologists, and discoverer of retro-viruses - one of them is HIV (Human Immunodeficiency Virus) - said, „HIV cannot be the only cause of AIDS."

According to earlier U.S. secret reports, Germany was planning in October 1943 to use radioactivity in war. In reports of the U.S. War Department of the 30th October 1943 the German warfare intentions are mentioned.

During summer 1943 Germany stopped the wolfram imports from Portugal. It was ordered to use uranium for the production of hard-core weapons in order to overcomes the critical situation which had thus arisen.

Through use of uranium weapons the progression of Sovietic (sic) tanks had to be stopped. As it was known in the meantime also sovietic (sic) industry worked at the development of such like weapons. In the beginning of the sixties German espionage tried with all means to get a new tank grenade, which the Soviets had supplied to the Syrian Army.

According to U.S. reports also the DU-ammunition was developed in Germany.

Depleted uranium has properties which make it highly attractive for armament industry:

1.) It is practically the heaviest naturally occurring substance;

2.) DU projectiles have a great penetrating power and are better suited for the purpose of penetrating steel armor plating than any other weapon;

3.) It is also an inflammable material. It ignites immediately on penetrating plates, releasing highly toxic and radioactive substances on combustion;

4.) After the [1991] Gulf War , since 1992 tanks are being manufactured with increased strengthening all around with a layer of DU.

In the meantime a German medical doctor and a German advocate have conducted research and demanded samples from Iraq since an employee of a German factory for tanks had become very sick.

As recently reported by the German news magazine, „Der Spiegel," (4/2001), the German armament factory „Rheinmetall" admitted it had developed and tested DU-ammunition since the early ‚70's. A German professor from Göttingen stated, „Rheinmetall" had offered him to survey test shots with various projectiles of Depleted Uranium manufactured by that company. DU-ammunition was also tested over a period of 17 years by the German armament factory combine, „Meserschmidt-Bölkow-Blohm."

On the 16th November 1997 it was pointed out during a press conference in Washington, D.C., that General [Arnold] Schwartzkopf, the high commander of the Allied troops during the [1991] 2nd Gulf War had not been informed about the side effects of the DU-ammunition of the German technology.

At the beginning of March 1991, I detected projectiles in an Iraqi combat area that had the form and size of a cigar and were extraordinarily

heavy. At a later point in time, I saw children play with projectiles of this kind, one of them died from leukemia.

As early as the end of 1991, I diagnosed a hitherto unknown disease among the Iraqi population, which is caused by renal and hepatic dysfunctions.

My efforts to have one of these hitherto unknown projectiles examined brought me into serious trouble in Germany: the material was highly toxic and radioactive. The projectile was confiscated by a large police detachment in protective clothes, carried away under enormous safety precautions and stored in a specially shielded deposit.

During the last 10 years I have been able to carry out extensive studies: Their results produced ample evidence to show that contact with DU-ammunition has the following consequences, especially for children:

1.) A considerable increase in infectious diseases caused by most severe immunodeficiencies in a great part of the population;
2.) Frequent occurrences of massive herpes and zoster afflictions, also in children. These diseases are related to the activities of viruses living in the human body;
3.) AIDS-like syndromes. In my opinion has low ionizing radiation also influences in virus infections of animals, e.g., BSE and mouth and foot diseases, but possibly also in bacterial infections of animals, e.g., tuberculosis which is increasing in Germany;
4.) A hitherto unknown syndrome caused by renal and hepatic dysfunctions, now called „Gunther Syndrome."
5.) Leukemia or other malignant neoplasm and aplastic anaemia by disturbance of the bone marrow;
6.) Congenital deformities caused by genetic defects, which are also to be found in animals;
7.) During pregnancy often abortion or premature birth;

In March 1994 reports on some 251 families of veterans of the [1991] Gulf War living in the state of Mississippi were published in the United States: 67% of the children of these families were born with congenital deformations - their eyes, ears fingers, legs, arms are missing or they are suffering from severe blood diseases and respiratory problems.

In the meantime others studying the facts have adopted my view that a parallel can be drawn to the situation that developed after the accident in 1986 in the nuclear reactor in Chernobyl. Since then there has been a sharp increase in cancer, especially among children. Their mortality rate is very high, as is the rate of malformations at birth.

In the opinion of the American nuclear scientist Leonard Dietz was the Gulf War in 1991 the most toxic was in history.

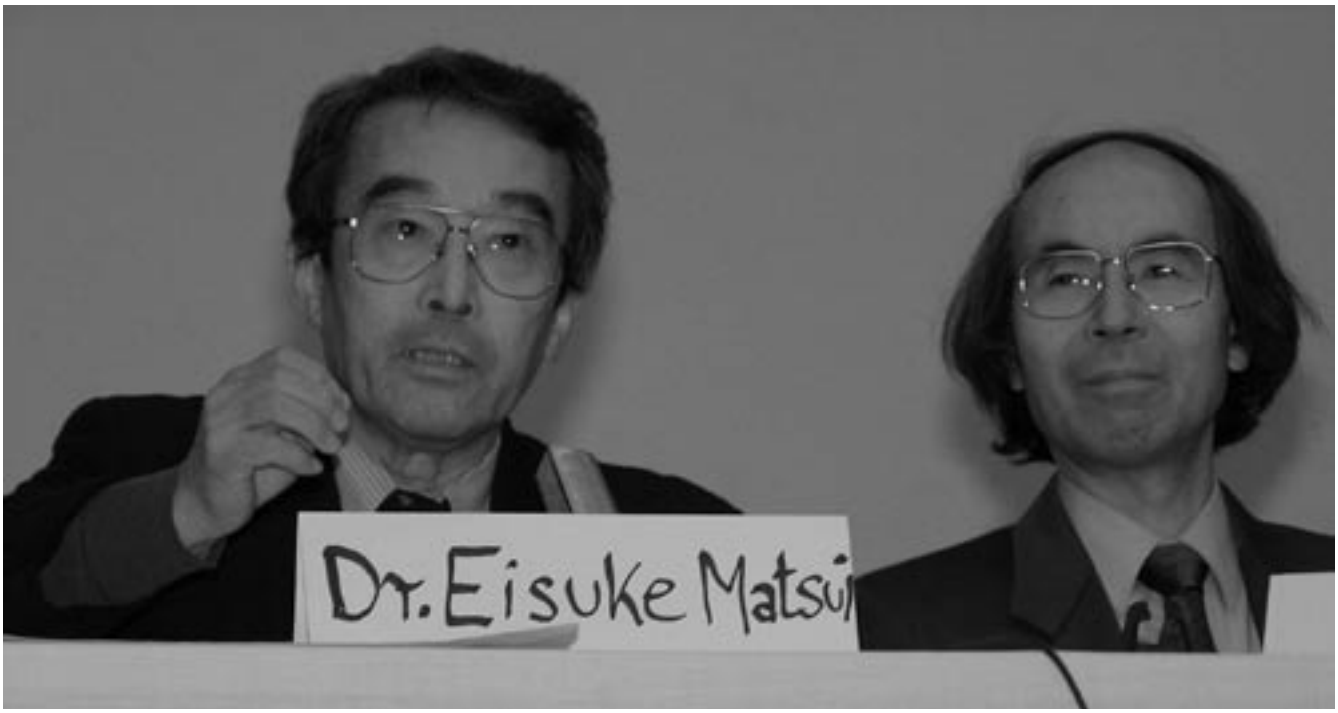
One cannot fail to point out , the disturbing situation that developed in Germany in 1988 after the US Army A-10 aircraft crashed in Remscheid. A similar situation developed in the Netherlands in 1992 after an Israeli El Al transport plane crashed in Amsterdam. It is suspected that both planes were carrying radioactive materials on board. In both cases in the region around the crash, there has been an increase in skin diseases, dysfunction of the kidneys, leukemia among children and malformations at birth.

In December 1997 and January 1998 the Balkan medias reported a dramatic increase of leukemia and other cancer development within the population of Srpska as well as an increased number of malformations in babies. The cows in this region show reduced and bloody milk production, while in others the milk production stopped completely. In several cases in calves malformations were registered: without skins, missing claws or tongues. This clinical picture was seen also in other mammals.

In my position as physician and scientist I call on those responsible as well as on the public: to prohibit the use of DU-ammunition, which is already at the disposal of several nations.

In the meantime Great Britain is planning to remove DU-ammunition from their disposal sites.

Dr. Eisuke Matsui, Japan



A report of the International Criminal Tribunal for Afghanistan in Japan

Dr. Eisuke Matsui MD, Gifu Research Institute for Environmental Medicine, Physician for Respiratory Diseases, Radiologist.

Since about 15 years I have been facing the historical truth of the war of invasion, harsh reality of war crimes and gross violation of human rights by Japan‘s government and Emperor‘s army before and in World War?. I have been joining the Japan‘s chemical and biological warfare research. In the early 1990s I became one of the active members of the Citizens‘ Committee for the Exhibit of Unit 731 Crimes. The Committee mounted an exhibition detailing Japan‘ biological

warfare research. The exhibition toured many cities, including my city Gifu, in Japan. More than 400,000 people viewed the exhibit. Professor Sheldon H, Harris described in his book, Factories of Death –Japanese Biological Warfare 1932-45 and the American Cover-up-(Routledge, London and New York, 1994), as follows; there are a number of international treaties being drawn up that seek to out law biological warfare, and, by implications, involuntary human experimentation. The Unite State, Russia (the former Soviet Union) and Japan are signatories to the various international agreements outlawing human experimentation, and production of biological warfare agents. Nevertheless, both these activities appear to be flourishing today in all three countries, as well as else where in various parts of the world. It appears that human testing, biological and chemical weapons will be part of former President George Bush’s so called new world order for some time to come.

Now, we have to say; it appears that human testing, biological, chemical and new type nuclear (namely depleted uranium) weapons have already been part of President George W. Bush’s so called new world order to come..

In 1991, we were very angry that the Japanese government supported the American invasion and bombing on Iraq. But we could not stop them. In 1992, Mr. Ramsey Clerk declared, “Defendant George Bush is guilty”. The Declaration encouraged us. We thought we could create citizen’s movement for real peace and solidarity in the international community.

The American bombing attack on Afghanistan started on October 7 2001. It is a crime in violence of international law. Afghanistan has been ignored and forgotten over twenty years while its land has been devastated and ruined by wars.

Yet the Bush Administration launched a war on Afghanistan, killing many women and children. Japan's Self Defense Forces cooperate with the United States by flying air refueling tanker planes.

Professor Akira Maeda (Tokyo Zokei University, Director of Japan Democratic Lawyers Association, Secretary General of Japanese Association for Human Rights of Koreans) gave a speech at the first public hearing the International Criminal Tribunal for Afghanistan held in Tokyo 15 December 2002, as follows ; if anti-war movement of Japan, Asia and the United States join together, sharing the knowledge and experience and act in solidarity, we may be able to clean up corruption and tyranny from the international community and to realize the world of lasting peace and friendship.

Many Japanese people, scientists, lawyers, students, etc. join the citizen's movement. We have been carrying out 13 public hearing including The 13th Public Hearing in Manila on 9/11/03 Thu.

I gave a testimony on the issue of Heath Effect of Depleted Uranium and other Internal Radiations at The 11th Public Hearing of the International Criminal Tribunal for Afghanistan in Tokai on 7/6/03 Sun. I emphasized especially the internal, chronic, isotopic exposure of depleted uranium, that is to say, nuclear site leukemia, Irish sea coast effect, Chernobyl infants, weapons fallout cancers(including Hiroshima and Nagasaki's), DU gulf veterans, Iraqi children, and Afghanistan children). Before and after the public hearing, I have been giving lectures on DU for citizens, junior high and high school students several times. I have been introducing to them ECRR 2003 Recommendations of the European Committee on Radiation Risk, because it is very important and essential so that we can act globally on a consensus of opinion against DU. We are going to held the 2nd and 3rd Tribunals in Tokyo 13 and 14 December 2003. We are planning to held the International Criminal Tribunal for Iraq next year.

http://afghan-tribunal.3005.net/english/index.htm

[CONFERENCE NOTE: Prof. Al-Aboudi Kadhum was invited to present at the Hamburg Conference, but was unable to attend due to unforeseen difficulties prior to his leaving. He did, however, make available this version of his paper, prepared for posting on the Conference website prior to the Conference. – Conference Staff]

Prof. Al - Aboudi Kadhum, Algeria

A Comparison of Effects on Animals and Enviroment from Ionizing Radiation from Above-Ground Weapons Testing in Algeria with DU Use in Iraq

Prof. Dr. Al- Aboudi Abdul Kadhum, Oran University, College of Science, Faculty of Biology, 31000 Oran P.B.1596 Algeria, E mail: aboudika@yahoo.ca

Introduction:

French nuclear tests in Algeria from 1960-1967 (Al-Aboudi 2000), and USA military activities in Iraq in 1991(Aalem Abdul Hameed , 1998) have thrown huge amounts of uranium contamination (and, in the case of Iraq, left thousands tons of depleted uranium, or "DU") over large areas of Algeria and Iraq respectively.

As a result, the people, animals, and environments in these areas have been and will continue to be irradiated by ionizing radiation for long periods of time.(Gunther 1994)

Tables Results: Hematological Analysis

Camels from	U A E	Botrosburg	Sudan	India	Egypt	Iraq	Algeria
WBC 10^3/ul	134-350	17.9-15.8	13-23	11.8-12.8	17.5-22	28-44	36-88
Haematocrit%	18.2-26			30.1-31.47	2.96-3.2	29.9	29.15
RBC 10^6/ul	5.3-6.2	5.65-6.31	7.83	5.5-6.2	8.9-9.9	11.8	12.55
Haemoglobin g/dl	7.5-11.1	13.6	11.1	11.5-11.8	12-14	14.8	15.55
VCM	34.4-42.8	38-65	40			48.66	50.76
TCM						24.3	26.51
CCM g/dl						46.27	56.51
Lymphocytes%	30-40	29-42	38			50.6	52.28
Plateles 10^8/ul	125-312			40	43-49	12.20	3.10
V. S 1h/2h				1.05-1.3 /1h		2.1 /1h	1.9/1h
Mean cell Hb	2-41.2					8-41.3	6-38.2
Neutrophils %	1-2		51	51	43-50	30	36.2
Monocytes %		0-1	4	3	2.78-4.5	2.4-5.3	3.2-4.7
Eosinophils %		3-13	4	6		4.2	3.2

There are strong associations between the rise in incidence of some health problems in Iraq and the exposure to the war environment since 1991, and also in Algeria since 1960.

This study aims to reveal the toxic effects of weapons used in nuclear tests and in war on cells counts and on cell structure of experimental animals which lived in regions contaminated with depleted uranium (DU). Biological samples collected from different bombarded sites showed positive results on experimental camels.

Many epidemiology of and many changes in hematological parameters were observed in blood samples taken from jugular vein of Iraqi and Algerian camels ,Camels dromadarious, in the southern governorates in Iraq, namely Basrah; and in the southern Sahara region, namely Ragan in Algeria.

This is an hematological analytic study comparing the various hematological parameters of the blood of camels which lived in two different regions: in south-Saharan Algeria, where they had been exposed to ionizing radiation from French nuclear weapons tests from 1960-68; and in southern Iraq, where they had presumably been exposed to ionizing radiation from the use of du weapons used by the Coalition Forces during the first Gulf War in 1991.

The study is designed to assess the association between the observed health problems of the animals which lived in regions contaminated with radioactive isotopes (from French nuclear weapons tests in Algeria and DU weapons use in Iraq), and their exposure to this radiation.

The following set of tables show also some clear differences in the values of hematological parameters between the exposed animals compared with another group of healthy camels which live in other clean environments

Many tests have shown leukemia in both Iraqi and Algerian people, camels and other animals. Within a given tissue, like blood, the cells vary greatly in their response to radiation and dose rate, the time, and period of exposure.

It is known (Eitam et al. 1976) that camels have high resistance to the various environmental stressors found in the different environments in which they live, and that their erythrocytes have osmotic resistance to hyperthermia and also to radiation effects.

The high hemolysis was observed in blood samples of camels, which had stayed a long time in some contaminated regions. From different studies and results, which were measured in our laboratory, erythrocytes of healthy camels showed a high resistance to heat and radiation. At the same time the human erythrocytes show more sensitivity to effects of radiation. That means the humans in these regions are more severely affected by the ionizing radiation.

Positive morphological changes counts of blood cells had been reported at different samples from different regions

Materials and methods:

Blood was obtained from [LIVE] camels, Camelus dromadarius. Whole blood was drawn by syringe from the jugular veins of donor animals in various regions. The blood was collected in citrated or heparinited tubes or EDTA as the anticoagulant.

All procedures were carried out on fresh samples at 0 to 5 C

The blood was filtered and centrifuged for 15 min at 1500 g. The plasma and buffy coat were carefully removed. Subsequently, the red cells were washed three times in 4 vol. of incubation medium whose composition has been reported elsewhere. (Shaafi and Hajjar, 1970)

Hemoglobin was determined from optical density at 540 mu after conversion of hemoglobin to cyanmethemoglobin. Counting was done in a well scintillation counter. .

Result and Discussion:

The tables show the results of analytical hematology and biochemical analysis for the blood samples.

The blood glucose concentration in more healthy camels (34 -126) mg% and showed in many samples in dangerous zones between (77 - 234) mg%.

The exceptionality high osmotic stability of camel erythrocyte show in the dangerous zone show fragility membrane through the high homolysis and the percent of Hb in the blood serum

Leukocyte counts were highest in camels which lived in dangerous regions, and the lymphocyte counts were highest in both young and older animals.

Some differences in plasma protein and glucose levels were found.

The samples of blood from camels in Algerian dangerous zones show high sedimentation in comparison with Iraqi samples.

Haemoglobin content was 14 and 12 respectively.

A few regions in south Algeria and Algeria showed total leukocyte count 22120/mm3 for males and about 18344 /mm3 for females. But there are no large differences between themes for camels in dangerous zones (where the leukocyte counts were much higher than normal) and those of healthy samples (sometimes between 140 - 358/ mm3).

We must also study the seasonal variation in the camel blood. (Ghosal A. K. ,et a 1973).

Biochemical Analysis for Algerian Camels from REGGAN Region

Biochemical Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Av. Value	Norm. Value Camel	Norm. Value Human
Glocos g/l	0.99	1.11	0.99	0.98	1.11	1.03	0.57	0.62	0.91	0.95	0.85	0.70	1.3	0.9	1.4	1.5	1.6	1.6	1.0	1.0	1.10	1.10	1.06		0.7-1.3
Uree g/l	0.41	0.39	0.33	0.38	0.49	0.53	0.25	0.18	0.38	0.28	0.28	0.20	0.20	0.20	0.60	0.10	0.20	0.20	0.20	0.30	040	0.30	0.30	0.05-2	0.21-0.5
Creatinine mg/l	10.2	8.05	9.46	10.3	12.1	12.1	10.3	8.25	9.6	10	12	9.75	10	10	11	6.1	9.1	8.8	7.8	8.3	10	12	9.82		
Cholestrol g/l	0.75	0.93		0.83	0.52	0.75	0.59	0.75	0.73	0.59	0.42	0.46	0.30	0.20	0.20	0.40	1.2	1.6	0.60	0.60	0.70	0.70	0.64		
Triglysirids g/l	1.09	0.94	0.54	0.38	0.29	0.20																	0.57		
Acid uric mg/l	6.61	3.34	1.24	5.82	0.87	1.61	40.6	10.6	7.8	2.9	8.4	2.7											7.71		2.5-8
Total protein g/l	62.6	70.3	72.4	65.2	68.7	66.7	69.9	65.1	59.5	62.5	66.8	58.4	61	58	67	66	52	47	51	49	60	77	62.54	57-75	60
Calicum m/l	10.9	9.2	93	10.1	9.2	10.9							9.5	9.1	10	8.9	9.2	8.7	10	8.5	9.7	8.8	14.77	9.5-11.5	
TGO u/l							54	24	29	16	40	41	37	14	35	39	28	32	39	27	31	19	31.56		9-23
TGP u/l							27	13	32	26	6	13	45	21	23	17	19	34	32	19	25	18	23.13		9-23
Bilirubin /T g/dl													3.2	3.2	3.1	4.7	5.7	2.9	2.9	7.3	2.2	2.2	3.74		
Bilirubin D/g/dl													2.1	3	1	2.7	1.7	2.6	2.4	3.1	1.8	1.6	2.20		

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Summary C.V Prof. Dr. Al-Aboudi Abdul Kadhum Born in Iraq in Misan , South Iraq.1/7/1947 BSc Physics University of Baghdad, Science College 1971 M.Sc Nuclear physics,1979, University of Lodz, Poland Ph D Biophysics, 1983, University of Lodz, Poland DR Sciences Radiobiochemistry, 1987, University of Lodz, Poland Director, research group on effects of radiation on cell membranes Author, more than 24 academic and scientific references. Author, DU and Its Impacts on Man and Environment in Iraq, 1994 Author, The French Criminal Nuclear Tests in Algerian Saharies, 2000 Member many scientific Qrganizations and Committees Actually Professor of Biophysics, University of Oran, Oran, Algeria.

Prof. Yuri

DU/UW Conference Special Addition:

NUCLEAR WHISTLEBLOWER STILL IN PRISON

Prof. Yury Bandazhevsky is imprisoned in Minsk, Belarus since June 18th, 2001. He is sentenced to 8 years hard labor by a military tribunal in Belarus. As a Doctor and an Expert on radiation exposure caused by the Chernobyl accident he was appointed in 1990 as Rector of the Gomel Medical Institute. Gomel has been the hardest hit area by nuclear releases. From 1990 to 1999, along with his wife Galina, also a Doctor, Prof. Bandazhevsky studied damages caused by Caesium137: heart diseases, cataracts, early aging, etc… He has discovered a measurable relationship between nuclear doses and various symptoms. In 1999, he published his results at a time when many people wanted to turn a blind eye to the problems and wish to send Belarus inhabitants back to the lands that are still contaminated.

Before his arrest in July 1999 he had written a report critical of the Belarus Government official research conducted with international funds regarding Chernobyl after effects. Prof. Bandazhevsky was arrested shortly after the issuance of this report on the basis of a Presidential Decree " for the Combat of terrorism."

Although bribery was the official charge, the real reason behind his sentence is related to his 9 years of research into the effects of the Chernobyl disaster. Bandashevsky remains in prison to this day – a reminder of the extent to which some governments will go to expunge the truth; and a symbol of the power of the human spirit to pursue that truth, whatever the cost. We remember him at this Conference, and urge readers to renew their support of efforts to win his release.

For information: http://www.comite-bandajevsky.org

The following is a reprint of an article from the WISE Communiqué #551 of 29 June, 2001, and a copy of a petition/manifesto for circulation. People can also sign the manifesto by going to the website above.

– The Editors –

Bandashevsky sentenced to 8 years in Gulag published by WISE News Communiqué on June 29, 2001

(551.5289) WISE Amsterdam - The news of Bandashevsky's sentence has come as a shock to other people involved in the campaign to help Chernobyl victims. Charges against him were made in 1999, when he was imprisoned from 13 July to 27 December (see WISE News Communiqué nos. 522.5120, "Belarus: Chernobyl medical expert in jail" and 523.5129, "Chernobyl medical expert out of jail, but charges not dropped"). After a campaign to free him, he was then released on probation and had to stay in Minsk until his trial.

He was charged with accepting bribes from parents for their children to be admitted as students to the medical institute. However, the witnesses subsequently retracted their statements against him, and the prosecutor in the case, Bozhelko, told a press conference on 17 February 2001 that the case was empty. Bozhelko was then taken off the case, and has since disappeared. His whereabouts are still unknown, and it is not known if he is still alive.

Bandashevsky, Belarus

The case was then transferred to the Supreme Court, who transferred it to the Military Tribunal in Gomel because Bandashevsky's co-defendant, Vladimir Ravkov, was previously a lieutenant colonel in the army. It was this tribunal that sentenced both Bandashevsky and Ravkov on 18 June.

Harry Pahaniaila, vice-chairman of the Helsinki Committee of Belarus, said, "According to our legislation, one can't submit a cassation complaint against this verdict.

But I have no doubt that Bandashevsky and his defense will complain against the verdict. In this case there were many violations.

For instance, Bandashevsky's right to defense was violated."

Belarus, which itself has no nuclear power plants, received a large proportion of the Chernobyl fallout, and dealing with the after-effects of the disaster consumes a quarter of the national budget (See WISE News Communiqué 547.5262, "Chernobyl 15 years on: health information still suppressed").

After the Chernobyl disaster Bandashevsky moved from Grodno, where he had been director of the central research laboratory, to Gomel, where he established the Gomel Medical Institute to help people in the contaminated region.

As rector of this institute, Bandashevsky carried out research into the effects of radioisotopes on vital organs of the human body following the Chernobyl disaster. Rats fed with cesium-137 were found to have pathological modifications to the kidneys, liver, heart and lungs. Bandashevsky and his colleagues then carried out 285 autopsies in the Gomel morgue, and found similar pathological modifications to those observed in the rats.

He thus discovered a direct relationship between a number of diseases and the concentration of radioisotopes in the body - something that is clearly embarrassing both for the Belarus government and the international nuclear lobby. Having found this link, he then identified compounds that are effective in eliminating radioisotopes from the body without side effects, which could be given to people living in contaminated areas. The Belarus Ministry of Public Health, however, ignored his findings.

Before his arrest in 1999, Bandashevsky criticized the Minsk Clinical Research Institute of Radiation Medicine for mismanagement of funds allocated for research into overcoming the consequences of Chernobyl.

This clearly made him unpopular with the authorities.

Bandashevsky is very sick, with heart and gastric problems, making it all the more vital to press for him to be pardoned.

A draft letter to send to the President, either directly or via the local embassy of Belarus, is included with this article.

Amnesty International are also expected to make an appeal.

A "Passport for Freedom" from the European Parliament will be presented on 3 or 4 July at Strasbourg to Bandashevsky's wife, pediatrician Dr. Galina Bandashevskaya. This has been signed by many European politicians including two former Presidents of the European Commission (Jacques Santer and Gil Roblès) and former European Commissioner Emma Bonino.

Devoino attack:

Two days after Bandashevsky was sentenced, Dr Alexander Devoino, deputy director of the independent radiation research institute Belrad, was attacked in front of the door of his home. He had been attacked with brass knuckles, and was left lying in a pool of his own blood. Doctors said it was the work of a "professional". It is thought that the attack was intended as a severe warning for Professor Nesterenko, director of Belrad (see box "Belarus Repression Continues" in WISE News Communiqué 547.5262, "Chernobyl 15 years on: health information still suppressed").

Belrad has performed 300,000 measurements of caesium-137 in foodstuffs and carried out measurements of radioactivity on 120,000 children. The data found were 8-10 times higher than the calculations performed by the Belarus Ministry of Health on the basis of individual samples collected in a few villages.

Concern over human rights abuses in Belarus continues in the run-up to the presidential elections set for 9 September this year. A US State Department report on human rights practices in 2000 stated, "The Government's human rights record was very poor and worsened significantly in many areas". Current developments appear to indicate that this trend is continuing.

Sources:

emails from Solange Fernex, 18 and 22 June 2001

"Qui est le professeur Bandazhevsky?", text by Wladimir Tchertkoff, December 2000

Web site www.spring96.org, 19 June 2001

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MANIFESTO FOR THE RELEASE OF PROFESSOR BANDAJEVSKY AND THE FREEDOM OF RESEARCH

Since June 2001, Professor Yuri Bandashevsky has been imprisoned in Minsk, Belarus. In 1990, Bandashevsky, a doctor and anatomo-pathologist, was appointed as Rector of the Gomel Medical institute in an area seriously contaminated by Chernobyl fall-out. Together with his wife, a pediatrician and cardiologist, Professor Bandashevsky studied the effects of Cesium 137 on children: cardio-vascular diseases, cataract, early aging etc.. and discovered a quantifiable correlation between the level of corporeal radio-activity and the severity of the symptoms. His findings were published in 1999, at a moment when many would have preferred to turn a blind eye and repopulate the contaminated areas. In his capacity as expert, he criticized the Belarus authorities for the misuse of international funding designed to alleviate the sequels of the catastrophe. Shortly after, he was arrested within the framework of an "antiterrorist" decree ...

Unfounded charges were then brought against him of having accepted bribes to admit students to his institute. After a trial before a military tribunal, Bandashevsky was sentenced to 8 years' imprisonment labor. During the trial, outside observers reported numerous infringements of the criminal code and the key witness for the prosecution retracted, claiming that he had acted under duress. Bandashevsky was adopted by Amnesty International as a prisoner of opinion.

We believe however, that in the Bandashevsky case, it was not solely the right to a fair trial that was violated.

Independently of what people may think of nuclear energy, what is at stake here is the right to know the truth, the right for scientists to carry out research and communicate their findings and the right of citizens to have access to knowledge without the interference of political and/or economic considerations.

The independence of all research in the service of mankind is a principle which is just as fundamental as the independence of Justice. Bandashevsky's imprisonment violates both these principles. It is for this reason that we, the signatories, demand the release of Professor Bandashevsky so that he may continue his research in his institute without harassment.

We invite all scientists, members of the university and citizens who wish to defend these principals:

1. to sign this manifesto for the freedom of research and the release of Professor Bandashevsky,
2. to promote his nomination as "Honorary citizen" of their town, as Clermont–Ferrand and Paris have already done,
3. to advocate his candidature as "Doctor honoris causa" of their university.

This manifesto will be published in a leading national newspaper before being forwarded to the Belarus government.

Felicity Arbuthnot, Conference moderator, UK

Prof. Huda Ammash, Iraq

Another Voice Not Heard

[One voice not heard, one presentation not given at the Hamburg Conference was that of Dr. Huda Ammash, Professor of Molecular Biology, President of the Iraqi Microbiological Society, University of Baghdad from Iraq. She has been "detained" by the U.S. occupation since shortly after the end of the 2003 Gulf War for alleged work on chemical and biological weapons, and for her membership in the Baath Party. The International Red Cross has no access to her at present. She is reported to have cancer. Scientists within Iraq, however, state she was doing important work on the effects of DU before the 2003 War started (see her study in CADU Manchester Conference 2000 and the Baghdad Conference Reader 2002). Her recent research on the issue got stopped by the last war and is for our knowledge unavailable. Prof. Huda Ammash observed the unusual phenomena of increased miscarriage rates in Iraq after 20 weeks into pregnancy. She spoke about the unusual triple breakages in chromosomes that were discovered in aborted babies there (the only other cases of triple breakages were in Hiroshima and Nagasaki), and about single cell malfunction. This type of damage she said doesn't occur spontaneously, but only because of radiation. Below is an article about Dr. Ammash written by journalist Felicity Arbuthnot for the Ecologist magazine.]

Written by Felicity Arbuthnot

Pack of lies

The `disappearance´ of `Mrs Anthrax´ is an utterly unlawful attempt to silence a respected scientist and critic of the US's use of depleted uranium weapons.

In increasingly surreal post-war Iraq, a world where those deemed `most wanted´ by the US are pictured on a pack of playing cards and given silly nicknames (`Dr Germ´, `Chemical Sally´,etc) in a mindset most people grow out of after kindergarden, the arrest of Dr Huda Ammash (`Mrs Anthrax´) is a cause of particular concern.

Dr Ammash, a graduate of the University of Missouri and Texas University is an internationally respected environmental biologist. Since the 1991 Gulf war, she has devoted much of her expertise to studying the health effects of the toxic and radioactive depleted uranium (DU) weapons used by US and UK on both the civilian population of the region and on Iraqi and allied soldiers.

She is a fellow of the Islamic Academy of Science, and has served as dean of both the College of Education for Women and the College of Science at the University of Baghdad. She has spoken around the world on the dangers of DU. At a major international conference in Manchester three years ago she and an expert from Hiroshima drew stark comparisons between radiation-linked cancers and birth defects in Iraq and Japan.

She also contributed a chapter to Iraq Under Siege: the deadly impact of sanctions and war, which was published in Britain by Pluto Press and South End Press in the US. Pointing out that DU weapons remain toxic and radioactive for 4.5 billion years, Dr Ammash drew attention to the illegality in international law of weapons whose effects continue to kill and pollute long after wars have finished.

The contribution to Iraq Under Siege include Robert Fisk, John Pilger, Noam Chomsky, Howard Zinn, All Abunimah and the former UN humanitarian coordinator in Iraq Denis Halliday. The book is a devastating condemnation of pollution, infant mortality and dodgy dealings at the UN – all the consequence of policies driven by the US and Britain.

South End Press has no doubt about the reason for Dr. Ammash's arrest, and is `outraged at the US extra-legal´ action. The publisher's Alexander Dwinell demands that Dr Ammash `be released immediately´, saying: The US government is trying to silence [her] outspoken criticism of the US role in causing cancers and other illnesses in Iraq through its use of biological hazardous weapons such as radioactive DU´.

It is deeply disturbing that those arrested by the US in Iraq are being `disappeared´ with absolutely no transparency and even more totally than those held in Guantanamo Bay. Ironically, that is exactly what happened under Iraq's previous regime.

Sabah al-Mukhtar, the president of the League of Arab Lawyers and whose practice frequently acts for governments (including, on occasion, that of Kuwait) is incandescent: `From A to Z this is illegal – from the occupation to the detentions; to target, detain, disappear without any charge being made public, with no legal representation, with no magistrate, public prosecutor or proper state representative having made the decision. For the US Army in Doha to issue a list of nationals in another country – it is unlawful, unlawful.´

With the ghost of Joe McCarthy walking tall in the White House, Dr Strangelove stalking the Pentagon and Machiavelli's descendents apparently running US foreign policy, the future looks bleak for Iraq, democracy and disappeared. Ironically, many Iraqis are already saying it was better under Saddam. Regime change anyone?

The Evidence For Causal Association Between Exposure To Depleted Uranium And Malignancies Among Children In Basrah By Applying Epidemiological Criteria Of Causality

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Abstract

Criteria for assessing causal association in observational studies (as described by Hill) have been applied to examine the association between exposure to depleted uranium and the rising incidence of malignancies (specifically leukaemias) among children in Basrah, southern Iraq following the 1991 military aggression on Iraq. These criteria include time sequence, dose - response relationship and consonance with existing knowledge.

The rise in the incidence rate of malignancies among children have been found to be noticeable from 1995 onwards (7.8/100000 in 1995, 10.7/100000 in 1999 and 13/100000 compared to only 3.98/100000 in 1990). Such trend fulfills time sequence criterion whereby the outcome follows a latency period of almost 4 years following exposure to depleted uranium. Examination

Prof. Alim Yacoub, Iraq

of the geographical distribution of such malignancies in Basrah over the period from 1993 to 2000 reveals that areas to the west of Basrah city (where levels of contamination of soil, plants and water with D.U are higher) have higher incidence of malignancies compared to areas east or south east. This finding fulfills dose-response criterion. The shift of the incidence of leukaemias in recent years towards younger children (below 5 years of age) supports the criteria of biological plausibility, specificity and consistency with findings from other parts of the world which have been exposed to ionizing radiation.

Introduction

The rise in the incidence rate of malignancies (specifically leukaemias) among children below fifteen years of age in Basrah following the 1991 military aggression on Iraq has been well-documented [1,2].

There is circumstantial evidence that such rise is due to continued exposure to depleted uranium which has been used by the western allies in their aggression. However such evidence need to be supported by applying more rigorous scientific methodology. Sir Bradford Hill postulated what has been called criteria of causality to establish the causal association between two variables in observational studies[3]. These criteria include time sequence , dose response relationship, consistency , specificity and biological plausibility or consonance with existing knowledge .

In this paper we report the results of applying such criteria to data which has been gathered on the incidence of malignancies among children in Basrah for the period 1990 to 2000 to examine its association with exposure to depleted uranium .

Methodology

It has already been mentioned earlier that a cancer registration system has been set up in the main maternity and children hospital in Basrah governorate, southern Iraq where information on all admited, malignant cases among children bellow 15 years, of are recorded and analysed by authors 1. It has already been mentioned that this hospital serves as the main referral centre for the management of malignancies among children in the area. Information on the incidence is updated every year and the the following indicators are calculated:

1 Annual incidence rate of malignancies per 100000 of children below 15 years of age. This is worked out by relating the registered numbers of malignancies to estimated population of children for that year

2 Percentage rise in the incidence of malignancies in general and leukaemias in particular for each year compared to the incidence in 1990 . This is calculated by the following formula:
Percentage rise in a given year =

$$\frac{\text{No. of cases in that year - No. of cases in 1990}}{\text{No. of cases in 1990}} \times 100$$

3. The spatial distribution of malignancies in Basrah by working out the annual incidece rate for each district of Basrah for the periods 1993 – 1998, 1999 and 2000 .

4 The proportion of children below 5 years of age with leukaemias out of total children affected for the period from 1990 to 2000 .

Results

The results of the study relevant to each criterion of causality are presented below.

A- Time sequence relationship

Table 1 presents the incidence of different types of malignancies among children in Basrah during the period from 1990 to 2000 . It can be clearly seen that a noticeable rise in total malignant is observed form 1995 onwards (38 in 1995 , 65 in 1999 and 92 in 2000) compared to only 19 cases in 1990 . The corresponding figures for leukaemias only are 25 in 1995 , 30 in 1999 and 60 in 2000 compared to 19 cases in 1990 .

The percentage rise in the in incidence of all malignant diseases and in the incidence of leukaemias are shown in fig 1 . It can be clearly seen that such rise started from 1995 onwards . The percentage rise in all malignancies compared to 1990 are 121% , 242% and 384% in 1998 , 1999 and 2000 respectively . The corresponding rise figures for leukaemias are 60% , 100% , and 300 % for the same years.

B- Strength of association

The annual rates of malignancies among children in Basrah from 1990 to 2000 are shown in table –2 .

The substantial rise in such incidence rates over the years is clearly demonstrated .The risks in 1995 , 1996 and 1999 are almost doubled compared to1990 . In 1999 it is almost 3 times higher and in 2000 it is four times higher compared to 1999.

C- Biological plausibility and consonance with existing knowledge

Table –3 show the proportions of children below 5 years of age with leukaemias out of total children below 15 years of age during the period 1990 to 2000 . The shift towards younger age group can be clearly observed .More than half of cases (57%) are below 5 years of age in 2000 compared to 13% in 1990. Such shift confirms early exposure of young population to radiation with succeeding years. It is well known that the risk of cancer among younger population exposed to radiation is higher.

D- Dose – response relationship

This criterion can be clearly ascertained by examining the geographical variation in the incidence rates of malignancies among children in Basrah over the period from 1990 to 2000.Table-4 demonstrates such distribution.

It can be seen that areas where higher level of background radiation was measured (such as Al-Zubeir west of Basrah city and Al-Hartha, north of the City) have higher incidence rates. Such rates are noticeable in 1999 and 2000.

Discussion

The demonstration of the causal association between cancer and a risk factor has always been based on epidemiological evidence. Application of Hill's criteria of causality has provided strong evidence for causal association between lung cancer and smoking or mortality due to cardiovascular disease among British doctors in relation to smoking [4] .

In this study the circumstantial evidence provided earlier on the relation between rising incidence of cancer among children in Basrah and exposure to depleted uranium [1,2] is further supported by the application of Hill's criteria of causality . Time sequence relationship criterion is fulfilled by the noticeable rise in such incidence of leukaemias starting from 1995 i.e. almost after 4 years of exposure to ionising radiation, a period equivalent to the latency period of this type of malignancy . Strength of association is demonstrated by the sustained rise in the risks of occurrence of malignancies among children in Basrah over the last 10 years. This reflects the results of cumulative exposure to radiation among the local population.

Earlier measurements of background radioactivity of soil , plant and water samples taken from different areas of Basrah[5] showed that areas west of Basrah had higher level of background radioactivity compared to eastern areas.

The results of the spatial distribution in Basrah of malignancies is consistent with the finding fulfilling dose – response criterion i.e. areas with higher level of exposure had higher level of cancer among children. The shift of incidence of leukaemias towards younger children is consistent with findings from other studies about childhood leukaemias among people living in the vicinity of nuclear reactors [6,7] .Thus the criteria of consistency and biological plausibility are fulfilled.

In conclusion, the evidence provided in this paper further supports the circumstantial evidence described earlier about the causal association between exposure to depleted uranium and the inc ence of malignancies among children in Basrah, southern Iraq

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Table 1 Incidence of malignant disease among children in Basrah

Year	1990	1993	1994	1995	1996	1997	1998	1999	2000
Leukaemia	15	15	14	25	24	24	24	30	60
Lymphoma	2	4	1	5	8	8	9	19	13
Brain tumour	1	4	3	2	5	6	2	2	3
Wilms tumour	1	3	2	4	1	0	0	3	0
Neuroblastoma	0	0	0	0	0	3	4	6	3
Others	0	1	1	0	0	2	3	5	13
Total	19	27	21	36	38	43	42	65	92

Table 2 *Incidence rate of malignant diseases among children in Basrah from 1993-2000 compared to 1990.*

Years	Children<15	No. of malignant disease	Incidence rate per 100,000
1990	476549	19	3.98
1993	518929	27	5.20
1994	533877	21	3.93
1995	459234	36	7.83
1996	565055	38	6.72
1997	581332	42	7.22
1998	627754	42	6.69
1999	605045	65	10.7
2000	704015	92	13.1

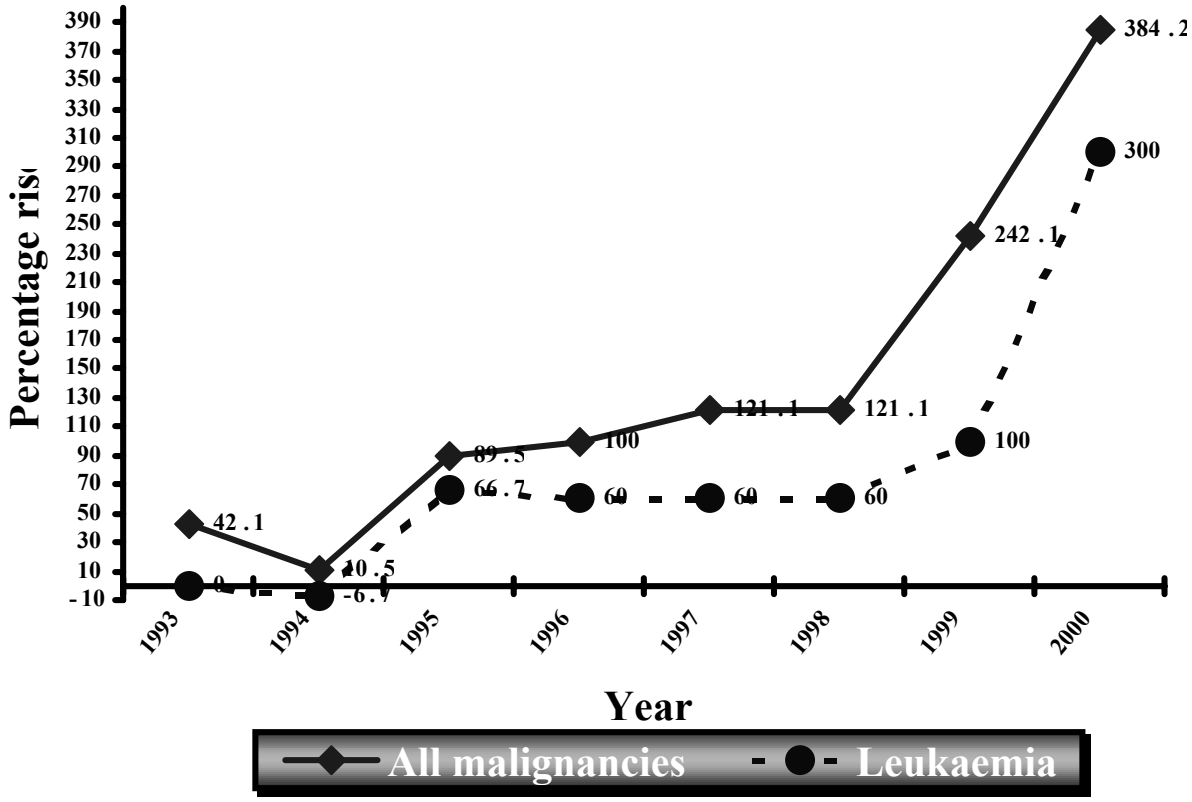
Table 3 ***Proportion of children below five years with leukaemia in Basrah 1990-2000***

Year	Total	< 5	%
1990	15	2	13.3
1993	15	5	33.3
1994	14	5	35.7
1995	25	10	40.0
1996	24	10	41.7
1997	24	10	41.7
1998	24	10	41.7
1999	30	14	46.7
2000	60	34	56.7

Table (4): ***Geographical distribution of annual incidence rates of malignant diseases among children 2000***

	Children < 15	No. of cases	Annual Incidence Rate Per 100,000
Centre of Basrah	295596	28	9.47
Alhartha	56186	24	42.7
Qurna	77581	10	12.89
Al-Mudina	57417	1	1.74
Al-Zubier	120443	25	20.76
Abu Al-Khassib	67088	2	2.98
Shat-Alarab	29703	2	6.7

Fig (1) :*Percentage rise in the incidence of malignancies in general and leukaemia's among children in Basrah with reference to the year 1990*



Dr. Rita Hindin, USA