RESEARCH REPORT

# Saving Iraqi Civilians and Their Environment from Catastrophic Implications of Depleted Uranium Used in Gulf Wars I and II

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## PREFACE

Lulea University of Technology had signed a MoU with the Iraqi Ministry of Higher Education and Scientific Research. Accordingly LTU is trying to highlight the most important problems experienced in Iraq that affects its people and the environment and to find possible solution to such problems. The human and environmental impact of the use of depleted uranium (DU) during war situations is an example of these problems of major significance for the Iraqi society. The issue is therefore addressed at LTU within the framework of the signed MoU. This report should be seen as a background survey of the problem and its extent for the Iraqi society.

The authors are thankful to LTU and a number of actors in Iraq for providing us with information and background reports of all types. The authors also like to stress the magnitude of the problem not only from an environmental point of view but also from the humanitarian aspect.

**ABSTRACT**

Depleted uranium (DU) was used twice by the Americans and allied forces against Iraqi troops and personnel in 1991 and 2003. The largest single radionuclide contamination occurred in the Gulf during Gulf War II, 1991, where depleted uranium was used as an amour-penetrating ordnance. Due to this use the countryside of Iraq was contaminated to a significant extent and thus chronically exposed the civilian population and military personnel to different environmental loads i.e. DU dust, vapors, and aerosols etc.

In addition to the radioactive contamination due to military activities in Gulf wars, other dangerous source of contamination has been reported from the material and equipment at the Iraqi Energy Authority. After the fall of the Baath regime in 2003, the Iraqi Energy Authority, like all other Ministries and governmental organizations, sustained immense losses due to the turmoil and looting. As an example the Middle East Media Research Institute (MEMI) reported in 2003 that uranium (as yellow cakes) as well as byproducts from processing activities in addition to tons of radioactive waste was stored in barrels. Simple citizens stole these barrels and used them for storing water. The radioactive materials in these barrels were in this way either spread in large quantities on the ground or taken to their homes. Other examples of how DU material is spread are given in the report as well.

This report is highlighting the effect of radioactive waste on the people and the environment of Iraq and trying to find possible solutions to the problem. Special concerns are directed to the question of finding sustainable, environmentally acceptable and safe landfills for the final deposition of DU contaminated material.

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**1. What is Depleted Uranium (DU).**

Uranium, a weakly radioactive element, occurs naturally in soil and water everywhere on Earth, but mainly in trace quantities. Humans ingest it daily in minute quantities.

Depleted uranium (DU) is a by-product of the enrichment of natural uranium for nuclear reactor-grade or nuclear weapons-grade uranium. Depleted uranium is chemically identical to natural uranium. In DU most of the 235 isotope has been extracted leaving mainly the non-fissionable 238 isotope. It is used to make the tips of armor-piercing shells because it is extremely dense: 1.7 times as dense as lead. In addition, unlike other heavy metals that tend to flatten, or mushroom, upon impact, DU has the ability to "self-sharpen" as material spread out by the impact ignites and burns off as the munitions pierces its target (Bollyn, C., 2004, Wagner, F. and Thurn, V., 2005¸ Rowe, D.G., 2003).

Though DU is 40 per cent less radioactive than natural uranium, its radiological and toxic effects might combine in subtle, unforeseen ways, making it more carcinogenic than thought. Depleted Uranium is "genotoxic". It chemically alters DNA, switching on genes that would otherwise not be expressed. The fear is that the resulting abnormally high activity in cells could be a precursor to tumor growth.
Depleted uranium weapons alloy is 99.8%, U238, emitting 60% of the alpha, beta, and gamma radiation of natural uranium (Wagner and Thurn, 2005 and, Durakovic 2003). When the DU penetrates hits an object it breaks up and causes secondary explosions. Some of the uranium used with DU weapons vaporizes into extremely small particles, which are dispersed into the atmosphere where they remain until they fall to the ground with the rain. As a gas uranium oxides, the chemically toxic and radioactive Depleted uranium can easily enter the body through the skin or the lungs and be carried around the world until it falls to earth with the wind and the rain.

DU is used in many forms of ammunition as an armor penetrator because of its extreme weight and density. The depleted uranium used in these missiles and bombs is a by-product of the nuclear enrichment process. Experts say the US Department of Energy has 100 million tons of DU and using it in weapons saves the government money on the cost of its disposal (Puppetgov, 2009; Hall, 2006).

In 1970, the US army started to test the capacity of DU as an armor penetration weapon instead of highly cost tungsten. It was found that a flying rod 30 mm in diameter of DU can penetrate 9 cm thick steel plates. Since that date US army is using DU in different ammunition forms. Other countries followed e.g. UK, France, Russia, Israel, Taiwan, Korea, Thailand, and Pakistan. Then weapons designers at the Pentagon came up with a use for the tailings. They could be molded into bullets and bombs. The material was free and there was plenty at hand. DU is perfect for use in armor-penetrating weapons, designed to destroy tanks, armored-personnel carriers and bunkers (Alshaikhly, 2003).

When the tank-busting bombs explode, the depleted uranium oxidizes into microscopic particles that float through the air like carcinogenic dust, carried on the desert winds for decades. The lethal bits when inhaled stick to the fibers of the lungs, and eventually begin to wreck havoc on the body in the form of tumors, hemorrhages, ravaged immune systems and leukemia. More than 30 percent of the DU fired from the cannons of U.S. tanks is reduced to particles one-tenth of a micron in size or smaller on impact. The amount of DU that is dispersed into the atmosphere is directly related to the size of the bang. With the larger

missiles and bombs, nearly 100 percent of the DU is reduced to radioactive dust particles of the "micron size" or smaller. Depending on their size, inhaled particles of radioactive uranium oxide dust will either lodge in the lungs or travel through the body,. The smallest particles can be carried through cell walls and "affect the master code - the expression of the DNA. (Bollyn, 2004; Ross, 2008).

DU debris is creating higher child cancer and other illness rates in Europe and the Middle East. DU's fine particles can be harmful as well to the lung, lymph nodes, kidneys, skin the lenses of the eyes and others. When inhaled or swallowed by humans, animals or fish, that dust can create serious and permanent health hazards. Expended DU is a permanent terrain contaminant with a half-life of 4.5 billion years. Depleted Uranium dust can linger in the lungs, lymphnodes, bones, blood and other organs for years. It is reported to have caused some of the so-called mysterious ailments among the more than 350,000 US service members, many of whom unsuccessfully sought medical treatment after the second Gulf War. At least four states (New York, California, Louisiana and Connecticut) tried to force the US Department of Defense to better test and care for Gulf war veterans for DU exposures. Their legislatures and governors were all concerned about sick service members exposed to DU wartime dust (Wagner, F. and Thurn, 2005).

Corroding DU penetrators embedded in the ground might pose a long-term threat if the uranium leaches into water supplies. After shell firings, the ground becomes polluted with depleted uranium particulate waste and some parts of the munitions themselves. DU contamination should be removed from areas around known penetrator impact sites. Long-term environmental sampling, particularly of water and milk, is required and provides a cost-effective method of monitoring sensitive components of the environment, and of providing information about uranium levels to concerned local populations. Monitoring may need to be enhanced in some areas, by site-specific risk assessment, if the situation warrants further consideration.

Traces of depleted uranium (DU) have been found in people even 20 years after their initial exposure. Depleted uranium (DU) has been found in the urine of Gulf War vets as long as 20 years after exposure. A highly sensitive test has been developed which can detect DU even when previous screening has proven negative (Weldon, 2008 and Gutierrez, 2008). This test may assist with unresolved health claims. Any form of uranium becomes exceedingly dangerous when burned, which is exactly what happens when DU is used in weapons systems. The tiny particles are aerosolized as DU Oxides, and can be inhaled into the lungs. The soluble DU compounds then enter the bloodstream and from there reach bones and organs. DU can remain, literally radiating the body from within, for years.
The use of DU munitions by the U.S. military may lead to a death toll far higher than that from the nuclear bombs dropped at the end of World War II.

The inevitable risk of uranium isotopes for the environment and human health has been clearly defined intensive research long time ago. However, still health care professionals are inadequately trained in the basic radio toxicity and chemical toxicity of uranium isotopes. The confirmation of the incidents of thyroid cancer, hepatocellular carcinoma, leukemia, and risks of acute and chronic exposure to uranium , has emphasized the importance of awareness of somatic and genetic consequences of contamination with uranium isotopes. The revisited Hiroshima and Nagasaki studies indicate that in addition to the physical effects there are also psychological impact of the chronic consequences of the use of nuclear weapons have been associated with a prevalence of psychiatric disorders, anxiety, and somatization of symptoms

among the victims who were present in the Japanese cities at the time of explosion. This clearly indicates long-term psychological consequences, which have to be taken into consideration in the preparedness for future incidents (Williams, 2008, Weldon, 2008 and Gutierrez, 2008).

Since 1999 several attempts were made by United Nations committee for a DU munitions ban worldwide because its long-term adverse health impact on civilians violates international law. In 2002, the World Health Organization recommended that "young children's exposure to depleted uranium must be monitored and preventive measures taken, and heavily affected impact zones for depleted uranium munitions should be cordoned off and cleaned up (Ross, 2008).

According to Afghanistan doctors the rates of some health problems affecting children have doubled in the last two years. Some researcher believes that this is linked to use of weapons containing depleted uranium (DU) by the U.S.-led coalition that invaded the country in 2001. Very high levels of uranium in Afghans were noticed during tests just after the invasion by Canadian research group (Williams, 2008 and UMRC, 2004).

European Parliament passed a global ban on such weapons with a landslide approval vote. There have been serious concerns about the radiological and chemical toxicity of the fine uranium particles produced when such weapons impact on hard targets ever since its use by the allied forces in the first war against Iraq. In addition, concerns have also been expressed about the contamination of soil and groundwater by expended rounds that have missed their targets and their implications for civilian populations (ICBUW, 2008).

There are numerous testimonies as to the harmful and often deadly effects of DU on both military personnel and civilians. Now there are great advances in terms of understanding the environmental and health hazards posed by depleted uranium. The use of depleted uranium in warfare is against the basic rules and principles enshrined in written and customary international, humanitarian and environmental law (Williams, 2008).

In October 2006, after decades of complaints about the hazards that US President signed into law a Congressional bill calling for a study of the health effects of depleted uranium munitions' firings on American troops, but not on the millions of foreign civilians exposed. As a result, a legislative committee is expected to ask the Army to review the accuracy of acute exposures and the cancer risks posed by them. It is noteworthy to mention that Belgium has banned the use of uranium in all conventional weapon systems. However, at least 18 countries, including the U.S., use depleted uranium in their arsenals despite the fact that they are considered weapons of mass destruction under international law. In addition, it showed be noted that Canada provides raw uranium to the United States and other countries for processing and the resulting depleted uranium is then used in weapons law (Williams, 2008).

Uranium shells made of natural uranium have been fired and are being manufactured by arms makers worldwide. This is so because natural uranium in the general environment is mostly in large particles created from natural weathering processes. The body seems to be able to eject these. In weapons however, uranium dust is formed at very high temperature into ultra-fine particles described as aerosols that can pass through cell walls etc. In the lungs these will go into soft tissue and stay there, rather than being coughed out.

In the meantime, tons of the old DU munitions are still in storage for potential firing by countries including the Great Britain and the United States. British are now using the hard metal tungsten to manufacture munitions formerly made of uranium, but U.S. Navy and Marines have abandoned depleted uranium munitions in light of their potential health hazards.

In the United States, DU munitions manufacturing operations have created numerous hazardous-waste concerns. The military has had to deal with firing range cleanups of DU, while the Energy Department is responsible for oversight of nuclear installations. The nation's military installations and nuclear weapons production facilities have accumulated many types of waste and contamination over the years. The federal government estimated its environmental liability to clean up this waste at $249 billion in fiscal year 2004 (Williams, 2008).

## 2. Depleted Uranium in Iraq.

Depleted uranium (DU) was used twice by the Americans and allied forces against Iraqi troops and personnel in 1991 and 2003. The largest single radionuclide contamination occurred in the Gulf during Gulf War II, 1991, where depleted uranium was used as an armour-penetrating ordnance, contaminated the countryside of Iraq, chronically exposed the civilian population and military personnel to DU dust, vapors, and aerosols.

During the second Gulf war in 2003 U.S. and British troops have reportedly used more than five times as many DU bombs and shells as the total number used during the 1991 war for the invasion and occupation of Iraq . It was estimated that more than 1100 to 2200 tons of DU was used. This quantity is 400 to 800 more powerful than the ones used in the first Gulf war. According to Okinawa (in Almuqdadi, 2007), every 800 tons of DU is equivalent to 83 nuclear bombs. Accordingly, about 250 nuclear bombs were fired on Iraq tell 2003 war.

Weyman in 2003 reported that the Uranium Medical Research Center cited in their report that the published data about the quantities of DU used in Iraq are as follow:

1. 24 Imperial Tons (21.8 Metric Tonnes). U.S. Army data related by U.S. Senator Jon Kyle, U.S. Senator, Chair of the Republican Policy Committee, in a letter to J. Cohen-Joppa, July 14, 2003.
2. 100 – 200 Metric Tonnes – D. Fahey, the Use of Depleted Uranium in the 2003 Iraq War: An Initial Assessment of Information and Policies, June 24, 2003.
3. 68 Metric Tonnes (75 Imperial Tons), representing calculations based on % of DU rounds loaded in total fired rounds of 300,000 by A-10 Thunderbolt. Reported interview of unnamed CentCom spokesperson, Christian Science Monitor, May 15, 2003.
4. 311,597 30-mm rounds, T M Mosley, USAF, By the Numbers, Operation Iraqi Freedom, Assessment and Analysis Division, USAF, April 2003.
5. 1,000 – 2,000 metric tones (1,100 – 2,200 imperial tons), posted in Associated Press article, The Environment in the News, UNEP Environmental Press Release Reports, Communications and Public Information, United Nations Environment Program, Associated Press, April 2003.

Christian Scherrer cited in 2003, based on the report of the 48th meeting issued by the UN Committee dealing with effects of Atomic radiation on 20th April 1999, noting the rapid increase in mortality caused by DU between 1991 and 1997, the IAEA document predicted the death of half a million Iraqis, noting that "...some 700-800 tons of depleted uranium was used in bombing the military zones south of Iraq. Such a quantity has a radiation effect, sufficient to cause 500,000 cases which may lead to death."
Despite this red alert and explicit scientific evidence of the horrific effects of uranium weapons, the US continued to use DU weapons of mass destruction in Bosnia 1995, Yugoslavia/Serbia 1999 and Afghanistan from October 2001.

The exact location that had been contaminated are spreading from south to north of Iraq.

In 2003, the Uranium Medical Research Centre (UMRC) conducted a team to investigate the areas contaminated by DU (Weyman, 2003). The team performed radiation surveys, nuclide analysis, interviewed civilians and community leaders, collected biological and field samples, and investigated the possible health effects of radiological weapons on Iraqi civilians. The types of locations investigated include:

- Ground-zero of acquired targets of the air bombing campaign.

- Disabled Iraqi armored assets and their defensive positions.
- Suburban, inner-city and agricultural areas that served as battlefields.
- Locations subject to both aerial bombing and ground combat.
- Collateral damage sites.
- Military facilities, air force bases and the perimeters of Coalition occupied bases.
- Down-wind and wide-area environments potentially subject to atmospheric, surface soil and ground water contamination.

UMRC's team surveyed bombsite and battlefield investigations, and sample collection activities were conducted in central and southern Iraq, covering major areas of engagement. Operation Iraqi Freedom executed two operational programs: "Rapid Dominance" and "Shock and Awe"; each was investigated by UMRC (Table 2-1).

As far as the "Rapid Dominance" is concerned the team traversed Iraq from the south to the north, beginning at the Gulf, Al Fau peninsula, and Coalition entry points at the port of Umm Qasr and the UN Demilitarized Zone at the Kuwaiti border adjacent to Al Zubair. Then they proceeded northerly along the Shaat al Arab corridor to sites of engagement led by the British forces approaching the city of Al Basra. Further investigation was carried out north to Al Nasiriyah where the US mechanized main column divided its forces into three: north-easterly along the Tigris River, north-westerly along the Euphrates River and centrally through the uplands of Mesopotamia. Along each route battle fields were surveyed, westerly through As Samawah to Al Najf, centrally through Karbala and As Suweirah, and easterly through Al Kuts and Al Hillah. Furthermore, they investigated a major combat area 60 kilometers south of Baghdad which was not reported during the war in the fertile plain of the Al Suweirah agricultural area. At the southerly approach-point to Baghdad, where the main northbound highways from the east and west converge at Baghdad Gate, the team made concentrated efforts also.
For the "Shock and Awe" (the air-delivered and ship- and submarine-launched bombing campaign) the field team investigated radiation levels at some of the highly publicized strategic military and civilian demoralization targets in Baghdad. In these places the explosions of ship-launched weapons such as the TLAM – Tomahawk Land Attack Munitions, and the air-delivered, precision guided bombs - primarily the CALCM – Conventional Air launched Cruise Missile, J-DAM – Joint Direct Attack Munitions, JSOW – Joint Stand-off Weapons, and the newly deployed British bunker-buster called the Storm Shadow - were took place (Weyman, 2003).

In addition to the radio active contamination due to military activities in Gulf war II and III, other dangerous source of contamination was from the material and equipment at the Iraqi Energy Authority. After the fall of the Baath regime in 2003, the Iraqi Energy Authority, like all other Ministries and governmental organizations, sustained immense losses due to the turmoil and looting. The Middle East Media Research Institute (MEMI) in 2003 carried out an intensive interview with formal researchers at the Iraqi Energy Authority and they disclosed the events that took place after the fall of Baath regime at the facilities of the commission. Tons of Uranium (as yellow cakes) as well as byproducts from processing activities in addition to tons of radioactive waste were stored in barrels. Simple citizens stolen these barrels and used they for storing water. The radioactive materials in these barrels were either spread in large quantities on the ground or taken to their homes. Later some of these barrels were used for drinking water while the others were used to sell milk. Some the researchers surveyed homes of some civilians and noticed that the contaminated barrels were

used to store food or daily household. When they were told that these barrels are contaminated they throw some of them in the river and others in waste sewer systems. About 4-5 houses were tested for outdoor contamination every day. There are The level of radioactivity on the walls of one of the houses was 30 billion/hour (the allowed level is 0.2) which means that it was 500-600 times more than the allowed level.

*Table2-1: Bomb sites, battlefields and communities surveyed and investigated by UMRC September 30 to Oct 13, 2003*

| Order of Investigations<br>Areas surveyed and sites investigated | "Overwhelming Force" Order of Battle<br>Operations Iraqi Freedom, Telic and Falconer |
|---|---|
| Baghdad area, heavy-weight bombsites:<br>• Baghdad Central Market<br>• Baghdad Central Telephone Exchange<br>• Al Rashid Air Force Base<br>• Baath Party Headquarters<br>• Ministry of Information<br>• Mansour District – April 7/03 leadership decapitation strike (Sector 613)<br>• Jammah Suburb # 512, Baghdad | Air campaign:<br>U.S. and British "Shock and Awe" Strategic Military and Civilian Demoralization bombing<br>Joint Air-delivered and Ship-launched Bombing Campaign by:<br>• U.S. & UK Royal Airforces<br>• U.S. and British Royal Navies<br>• 15,500 strike sorties<br>• 27,000 bombs<br>• |
| Baghdad combat battlefields, US led:<br>• Haiyy al Mavalemeen – Teachers District<br>• Auweirj Coalition/SRG HQ<br>• Tank-graveyard<br>• Baghdad Gate | Ground force battles<br>Advance and Battle for Baghdad: "Rapid Dominance" Comprised of two main divisions, western and eastern, main columns advancing from Kuwait to Baghdad.<br>• U.S. 1st Marine Expeditionary Force – East<br>• U.S. 5 Corps – West<br>• U.S. 3rd Mechanised Infantry Division<br>• Close-in air support:<br>- 101st Air Assault Division<br>- 82nd Airborne Divisions |
| Central Iraqi, U.S. led combat:<br>• Suweirah and Suweirah Air Force Base<br>• Salman Pak Road Battlefield<br>• An Najaf and Diiwaniyah<br>• Karabla and Al Husseiniyah<br>• Al Kut<br>• Al Hillah<br>• An Nasiriyah | UK Operation Telic & Operation James<br>Combat Joint Special Operations Task Force; including Australia - Operation Falconer<br>• 3rd Commando Division (Desert Rats)<br>• 1st UK Armoured Division<br>• 7th Armoured Brigade<br>• 2nd Close Support Division (Royal Logistics)<br>• 16 Air Assault Brigade & SAS Sabre Squadron |
| British led combat:<br>• Battle for Al Basra<br>• Az Zubayr (Kuwaiti/Iraq DMZ)<br>• Al Ashar and Abu Khasib<br>• Basra Canal and Shaat al Arabi corridor<br>• Al Faw peninsula<br>• Umm Qasr | |

In other parts of the Iraqi Energy Authority, there were about 200 barrels of isotopes and radioactive materials as well as yellow Uranium Oxides; they were all spilled on the ground. If a strong wind blows, it can carry these quantities to great distances outside.
In addition, insects were kept in 4 labs where these insects were used as biological insecticides. The expected ecological disaster from releasing thousands of flies known as chrysomya bezziana, nicknamed screw worm, which were bred by the Nuclear Authority to be used as biological farming insecticides. They Iraqi police and the Americans were fully

informed about these labs but nothing was done to protect the people from these harmful insects. The flies were released by the looters and were expected to harm animals in Iraq and neighboring countries. These flies were to be released after being sterilized (Weyman, 2003).

Hall in 2006 reported that with the arid climate of Iraq, sandstorms blow tiny particles of DU away from the blast epicenter, impacting the surrounding environment without geographical limitations. These particles enter the soil, polluting the water table, the Tigris and Euphrates Rivers, and infecting the food chain. Fertile grasslands west of Basra in southern Iraq, contaminated with DU, produce vegetables and grains for livestock that are consumed by American troops as well as Iraqis (Weyman, 2003).
The New York State National Guard Rainbow Division spent six months stationed in Camp Forward Danger on the Tigris River near Tikrit, north of Baghdad. This city is Saddam Hussein's rebellious hometown was the site of major combat using DU munitions during the initial invasion and for months afterward.

During that period the soldiers were taking radioactive showers and washing small open wounds in a depleted uranium broth. They have eaten over 500 meals with food, plates and silverware washed with hot water, in two senses of the word. So now the Tigris River, the Bible's Edenic River of life, has become a modern river of death and the people there are drinking the forbidden water, without knowing it.
Hall (2006) stated that no place in Iraq is free from radioactive contamination, even what is referred to "safe" Green Zone in Baghdad where top military officers, civilian occupation authorities, international journalists, and the Iraqi government leaders live and work.

## 3. Consequences of Depleted Uranium in Iraq.

Numerous research had been carried out about the effect of DU in various part of the world (Durakovic, 2003, Durakovic et al 2003, Miller et al 2003, L'Azou et al 2002, Arfsten et al, 2001, Gu et al 2001, Pellmar et al 1999, Kennedy et al 1996, Lehnert et al 1997, Kadhim et al 1994, Kadhim etal 1992). They also analyzed differe nt parts of the body to detect the effect on these parts. Scientists noticed that DU is organotropic and ultimately gets incorporated into target organs, such as the skeletal tissue where it has a long-term retention. It is also slowly soluble, uranium isotopes are gradually decorpor ated from the retention sites and have been detected in the urin e of Persian Gulf War I ve terans 10 years after i nhalational exposure or shrapnel wounds. Studies of tissue distribution reported DU accumulation in the bone, kidney, reproductive system, brain, and lung, with ve rified genotoxic, m utagenic and carcinogeni c properties, as well as reproductive and terato genic alterations. Recent studies on anim als embedded with DU pellets confirm the findings of previous Biological distribution studies that the kidneys and bones are target organs for uranium isotopes, with other identified sites in the lymphatic, respiratory, reproductive and central nervous systems.

DU isotopes were detected in the Br itish, Canadian, and United States Gulf War veterans as late as nine years after inhalational exposure to radioactive dust in Gulf War I. Autopsy for a Canadian veteran's samples of lung, liver, kidney, and bone showed DU isotopes. They contained high concentrations of uranium , with the isotopic ratios indicating the presence of DU. Early studies perform ed in 1991 by w hole body counting, suggested evidence of the presence of uranium in the body and urine of the contam inated veterans. Research has progressed about DU in veterans' bodies to evaluate the clinical effects of contamination with uranium in Gulf W ar I veterans, the civili an population of Iraq, m ilitary personnel and civilians in the Balkans , and civilians in Afghanistan, and more recently, Gaza an d West Bank, Palestine.

Recent evidence, from human data reports, abo ut the mutagenic effects of alpha particles o n stem cells and alpha-radiation induced chrom osomal instabilities in human bone marrow cells are of particular im portance(Kadhim et al 1992 and 1994).Low dose of alpha particles can cause sister chromatid changes in normal human cells (Lehnert et al 1997). The lung remains the principal portal of entry of uranium isotopes into the body; the skeletal tissue being the final target organ (Durakovic, 2003).

In 1991 during Gulf War I resulted in 350 m etric tons of DU deposited in the environm ent and about 3 to 6 m illion grams of DU aerosol re leased into the atmosphere. This caused later what is known as the Gulf war disease. These methods, identifying 0.2-0.33% of U235 in Gulf War I veterans, demonstrate uranium con centration of 150 ng/L at the original time of exposure, as compared to the non exposed popul ation in the Gulf who contained 0.7 to 1.0% of 235U, indicating a urinary uranium concentration of only 14 ng/L (D urakoviæ 2003). The long physical and biological half-life, alpha pa rticle decay, and well-established evidence of somatic and genetic radiation toxicity suggest a viable potential role of DU in the genesis of Gulf War and Balkan Syndromes (Durakovic, 2003).

The armor-piercing shells made of depleted uranium which were first used in warfare by US-led troops during the1991 Gulf War and then during the 2003 i nvasion, turned many parts of Iraq to radioactive toxic wastelands. Many soldiers participated in Gulf war 1 and 2 were sick. A study conducted on nine recen tly returned so ldiers from the New York National Guard showed that nine were found to have "alm ost certainly" inhaled radioactive dust from

exploded DU shells. About one out of every th ree veterans from the first Gulf W ar is permanently disabled due to DU e ffect, and 179,310 veterans of the 592,561 discharged from the 1991 war in Iraq, are r eceiving disability com pensation and another 24,763 cases are pending (Bollyn, 2004).

Two manmade forms of uranium in urine sam ples from four of the 9 soldiers were revealed by laboratory tests. They are the first confirm ed cases of inhaled DU from the second Iraq war. These soldiers were military police not exposed to the heat of battle indicating that other soldiers engaged in combat m ust have m ore DU exposure. Over 30000 casualties were reported in Iraq (Bollyn, 2004).

In 2001 it was found t hat DU, including U 236, in 62% of the sick gulf war veterans, it is believed that particles lodged in their bodies and may be the cause of their illness. They had significant levels of uranium in their urine seven to nine years after th e war. In 2003-05, after the first gulf war, the level of radiation was 300 times more than the normal level where more DU bullets were used in that war (Ross, 2008).

Physical abnormality is increasing after the Gulf war where of 13,191 pre gnancies among the partners of m ale Gulf vets, 686, or 5.2 percen t, had some for m of physical abnorm ality, compared with 342, or 3.5 percent, of the 9,758 non-Gulf pregnancies ( LaForge, 2004). Doctors in Iraq diagnosed severe leukem ia in s ome of the soldiers where 38 of them died a few hours after returning home to Lima, Peru. They had leukemia because they were exposed to DU, even though one of them ha d served in Baghdad for a short period. He served in the Baghdad Green Zone area (Hall, 2006).

Following the invasion of Iraq in 2003, over 140,000 cases of cancer has been reported, which are believed to be caused by toxic w eaponry used by the occupying troops. It is reported that 2,000 tons of (DU) expe nditure were used during the invasion (Press TV, 2010, Ross , 2008). In addition it has resulted in many grossly deformed children born in areas such as southern Iraq where tons of DU have contam inated the environm ent and local population. An untold number of Americans veterans have also been born with severe birth defects as a result of DU contamination. Babies whose fathers served in the 1991 Gulf war are 50 percent more likely to have physical abnorm alities, in addition it wa s also found a 40 percent in creased risk of miscarriage among women whose partners served in the war (Bollyn, 2004).

Many soldiers participated in Gulf war 1 a nd 2 were sick. A study conducted on nine recently returned soldiers from the New York National Guard showed that nine were found to have "almost certainly" inhaled radioactive dust from exploded DU shells. About one out of every three veterans from the first Gulf War is pe rmanently disabled due to DU effect, and 179,310 veterans of the 592,561 discharged from the 1991 war in Iraq, are re ceiving disability compensation and another 24,763 cases are pend ing (Bollyn, 2004). Tw o manmade forms of uranium in urine sam ples from four of the 9 so ldiers were revealed by laboratory tests. They are the first confirm ed cases of inh aled DU from the secon d Iraq war. These soldiers were military police not exposed to the heat of battle indicating that oth er soldiers engaged in combat must have m ore DU exposure. Over 30000 casualties were reported in Iraq (Bollyn, 2004).

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*Figure 1: Parts of Baghdad (Source Iraqi solidarity News, 2006)*

*Figure 2: Parts of Baghdad (Source Iraqi solidarity News, 2006)*

**A** **B**

*Figure 3: A. Part of Baghdad B. Depleted Uranium Bullets.*
*(Source Iraqi solidarity News, 2006)*

a b

*Figure 4: a-contaminated tank (source Puppetgov, 2009)*
*b- US-led troops used 320 tons of DU against Iraq during the1991 Gulf war and about 2,000 tons in the 2003 invasion (Source Press TV, 4 April 201).*

*Figure 5: American activities on Iraq (source http://www.notinkansas.us/du_3.html)*

*Figure 6: Military operations in Iraq (source http://www.beelink.net/20030225/1304806.shtml)*

Near Baghdad the readings of Geiger counter in 2003 were 1000 and 1900 times the normal reading, where bunker buster bombs and munitions had exploded near Baghdad. These bombs contain more than one ton of DU. According to IAEA half million were dead between 1991 and 1997. Furthermore, it was estimated that 700- 800 tons of DU were used in the bombing the military zone south Basrah, this amount is sufficient to cause 500 000 cases which might lead to death (Ross, 2008). Almuqdadi (2000) stated that the United Kingdom Atomic Energy Authority (UKAEA) warned the British Government of the use of DU weapons in the Gulf war. Such weapons lead to cancer and threat the life of humans near the destroyed equipment and even those looking at them (Felicity Arbuthnot, 1991) . Almuqdadi (2000) further mentioned that the American Defense Nuclear Agency warned from serious consequences due to the use of DU weapons. Nick Cohen ( 1991) reported that the amount of DU present in Kuwait and South of Iraq is capable of killing 5 000 000 people . Almuqdadi (2000) stated in New York Times, 1992, and other researchers confirmed, the effect of DU on the people in the Gulf area.

In one of Baghdad hospitals, they noticed during seven years, that babies are born with congenital abnormalities, but very late spontaneous abortions occur because of congenital defects. Previously, one case used to be reported per month and now it is two to three cases being reported each day, which is equivalent to about 1000 cases per year in one hospital (Ross, 2008). Malignancies in children at Basrah hospital raised 240% from 1990 to 1999 (Paulinson, 2006). It was estimated by UNICEF that there are about 6,880 deaths of children under the age of five every year in Iraq, with an under-fives mortality rate of 125 per 1 000 live births. In addition, the mortality rate of Iraqi women during pregnancy and childbirth has reached three times the rate reported during the period between 1989 and 2002 (Hassan, 2004).

During 1991 war DU ammunition was mainly used against Iraqi tanks in the desert near Basrah, while in the second war was used all over Iraq even in densely populated areas including the heart of Baghdad, Mosul, Tikrit and other cities. It is believed that the death toll may surpass a million deaths over the next few years. Some Iraqi doctors estimate that more than 40% of the population around Basrah will get cancer i.e. 680 000 out of the 1.7 million people living in the area (Ross, 2008). Leukemia in Iraq had been grown up more than 600% since 1990, similar trend was noticed in Sarajevo after American bombing in 1996 where

leukemia tripled within 5 years. In addition NATO and UN peacekeeping troops in the region are also suffering from cancer (Ross, 2008).

Cancer has increased dramatically in southern Iraq. In 1988, 34 people died of cancer; in 1998, 450 died of cancer; in 2001 there were 603 cancer deaths. (Johanson, 2002)
In August 1998, 10 babies were born with no heads, eight with abnormally large heads and six with deformed limbs in Basrah, furthermore, cancer cases raised from 80 cases in 1990 up to 380 in 1997 (Ross, 2008). There were photos of cancer patients as well as infants without brains, with their internal organs outside their bodies, without sexual organs, without spines etc (Johanson, 2002). The rate of leukemia in Iraq has grown by more than 600 percent. Most of the leukemia and cancer victims are not soldiers. (ST. Clair and Frank, 2004)
All Iraq is not free from radioactive contamination, including what is called "safe" Green Zone in Baghdad, where top military officers, civilian occupation authorities, international journalists, and the Iraqi government leaders live and work (Hall, 2006).

## 4. Clean up activities of DU contaminated areas in Iraq.

Major areas of engagement in Operation Iraqi Freedom cover more than 300 sites all over Iraq. The soil as well as the military equipment in all these sites are believed to be contaminated by DU used by American and allied forces. Due to the abnormal high radiation rates in these sites and their effect on humans and environment, the Iraqi Government and the American and allied forces (coalition forces) carried out clean up and soil replacement activities.

Uranium Medical Research Centre (UMRC) carried out a comprehensive survey on the sites where coalition forces tried to clean in Iraq (Weyman, 2003). UMRC reported what their team had seen in four main sites. The first site was in Baghdad, the second in Basrah and the third in Nasiriya. Generally the operations are carried out by U.S. military engineering units and Iraqi contractors escorted by U.S. army security forces in the process of clean-up operations of bomb and battle sites.

As far as Baghdad sites are concerned, they first visited the U.S. occupied base in south-western Baghdad in the Auweirj district which is close to the International Airport and hosts one of the largest Coalition bases around Baghdad, occupying the operational headquarters of the Iraqi Special Republican Guard. The area was subject to considerable aerial bombing and rocket fire prior to the Coalition ground forces' arrival. Then it was followed by several ground skirmishes along the main routes to the International Airport and western entrances to the City. This area is very close to Mansour District and the main route to many bridges crossing the Tigris into the downtown core. They stated that when the UMRC team arrived to the site a cloud was blanketing the Coalition-occupied base, depositing a layer of fresh dust on people, houses, automobiles, and the highway. There was a steady stream of tandem-axle dump trucks carrying full loads of sand leaving the site, heading south away from the city while a second stream of fully loaded dump trucks was waiting to enter the base returning from the south. At the base, bulldozers were spreading soil while front-end loaders were filling the trucks that had just emptied their loads of soil (silt and sand). The arriving trucks were delivering loads of sand into the base while the departing trucks were hauling away the base's topsoil. This operation was going on for months. The aim of this operation is removing potentially contaminating soils from their living and working areas. Due to this exercise, it was noticed that lofting tones of fine, light dust was going on into the local environment, which was then falling back to inundate square kilometers of residential neighborhoods and Coalition occupied facilities. These clouds are lofting above and spreading over the entire area of at least 5 000 000 residents in Baghdad alone.

The UMRC team reported that in several locations, the potentially contaminated soils were dumped so as to establish defensive berms and fill perimeter security caissons surrounding occupied facilities. Also it was reported that this kind of practice was noticed inside several cities.

The second important site visited by UMRC team was Baghdad Gate, Route 6, is the main entry point to the city from the south. It is a massive concrete monument with a double archway spreading over the six-lane. Strategically this gate was very important to the Iraqi defense of Baghdad due to the intersection of the main northbound highways, flanked by the river and forcing all traffic into a slow moving bottleneck. In view of its importance, Iraqi tanks and anti-aircraft guns established a major defensive position beside and under the Gate, dug into tank pits and foxholes in the trees and hiding in the orchard perimeter east of the

highway. A stiff battle ensued at this site where helicopter gun-ships and armored vehicles engaged the Iraqi's position. The Iraqi tank crews were bailing out of rocketed and burning tanks to be killed by a hail of both U.S. suppression fire and their own friendly fire as they ran towards the orchard for cover. The battleground was almost completely covered with piles of sand and bombed-out building debris trucked into the site and pushed over most of the combat area. This cover up was careless and incomplete. Open and exposed were the scorched and twisted remains of tanks decimated by continuous heavy fire of high explosive rockets and radioactive kinetic penetrators. This was left as well as the remaining metal parts, tank treads clothing and piles of spent and unspent ammunition, littered foxholes and defensive pits where tanks and other assets had been hidden to lower their profiles.

Earth-moving crews were observed "landscaping" the battlefields in various sites in Baghdad where this work began shortly after the cessation of the major combat engagements. The work in Baghdad was systematic, but it was noticed that incomplete effort was invested to isolate and rectify contaminated sites. A program of removing damaged and disabled military assets was started. The emphasis had been placed on the visible sites easily accessed along the roads and highways. Most of the debris (Iraqi tanks, armory personnel carriers and artillery pieces) had been winched out of their defensive positions, loaded onto flatbeds and transported to the tank graveyards in Auweirj and the occupied airports. However, it still remains a small number of damaged tanks and other disabled armored assets along secondary roads, back yards, and in farm fields in Baghdad.

Nasiriyah was the third site reported by UMRC. This site was defended by an Iraqi mechanized, heavy armor group. At the site, the toughest engagements fought by the 1st U.S. Marine Expeditionary Force against the Iraqi army took place with the goal to control the entry to Nasiriyah located on the bridge across the Euphrates River. To slow the Coalition's advance, five T-72 Russian-built MBT's (main battle tanks) were dug into a low-ground position between the road and the adjacent Aluminum Fabrication and Engineering Company's employees' residential quarters. This type of defensive place was usually used by the Iraqi army close to urban cover, occupying the low ground, not the high ground, extending the survival time by avoiding close in air cavalry attacks, and limiting visibility by oncoming forces with an escape route at the back. Two of the five tanks were pulled up and out of the battlefield, over a steep and difficult pitch and on to the flatbeds and transported to a secure location at the Coalition occupied airport. Ten months later, UMRC team investigated this battlefield to find the three remaining tanks were radioactive. G-M count levels in the area was several hundred times background value and the residents of the houses located within 30 meters of the tanks reported being warned by the U.S. survey team where teenagers in a group watching the survey work and tank removal were advised by an interpreter not to play in the tanks because they could get sick.

The fourth site reported by UMRC was Basrah area where the advance on Basra was commanded by the British under the code name, Operation James (a sub-division of Operation Telic). The site was defended by three Iraqi mechanized tank divisions, marine units using the canals and rivers, and a host of paramilitary and local resistance groups. The largest concentration of disabled Iraqi main battle tanks (MBT) and the largest battlefield in Iraq are found at Abu Khasib, south of Al Basra. Basra, with 1.5 million residents, the second biggest city in Iraq, was under the control of the British forces. Basra's combat areas remained unchanged for seven months from the end of the battle till the visit of the UMRC team. The British army warned residents and local salvage and recycling crews (described as looters in the western press) that the tanks in this battlefield were radioactive and must be

avoided. The British army has taken no steps to post warnings, seal tanks and army personnel carriers or remove the highly radioactive assets from these sites. The UMRC team found radioactivity in and around most tanks in this battlefield as well as elevated levels on the soil surface, in the air and inside occupied buildings situated in the battlefield. It should be mentioned that the tank's diesel engine and several forged metal parts have been removed and recycled into the community.

The activities of the Iraqi Governments in this context are very limited. The Ministry of Environment and Ministry of Science and Technology are supposed to arrange a plan to get rid of the military scrap contaminated with DU. The contaminated location were pin pointed by IEA and a plan was put to clean these sites (Aldistor, 2008). Almuqdadi (2007) stated that the Iraqi Government tried to re-melt the military scrap and re-use it. Later they tried to sell the scrap to neighboring countries. Some of the scrap was exported to Jordan and later was returned back to Iraq because the Jordanian authorities discovered that it was radioactive. It was reported that 50 trucks were not allowed to enter Jordan due to the fact that it was loaded with forbidden weapons. Alobaidy (2005) wrote that in 1991 a specialist in DU affairs mentioned that the DU ammunition used in Iraq in 1991 was 940 000 bullet 30 mm and 14000 artillery and tank bomb. Further he added that 3700 sites were destroyed of which 1400 with DU. He also believed that the British forces used 100 tons of DU in Basrah during 2003 military operations. Hatem (2005) reported the presence of thousands of tons of military scrap in Basrah area, later Ahamd (2010) stated they the scrap amounts to 87 816 tons of contaminated scrap. News sites are always discovered contaminated with DU (INA a, 2009) and reports also indicate that scrap removal operations had been stopped for technical reasons (Aswat aliraq, 2009).

Tareek alshab news paper (2009) reported that the Iraqi Minister of Environment stated that not more than 10% of contaminated DU military equipment was buried. Other governorates also reported the presence of contaminated radioactive sites. Among these are, Mesan (Alkomati, 2009) where two sites were reported. In Thikar, 71 sites were reported contaminated with DU (Hamed, 2009, Habeeb, 2009 and INA c, 2010). Six contaminated sites were also reported in Babylon governorate (INA b, 2009). The authorities in Mothana governorate had distributed warning leaflets to the civilians about the contaminated military equipment (IBN, 2009 b). Even in the capital city Baghdad various new contaminated sites were reported (Alkalaby 2009, Iraq Baitina 2009, Majed 2009, Ur News a,b 2009).

Reporters continue to investigate the DU problem in Iraq (Peterson, 1999, 2002, 2003). Recently, a scientific team from Babylon University announced that they have discovered 6 new contaminated sites, they also stated that the number of cancer patients is increasing abnormally (INA b, 2009). Chulov (2010) indicated that more than 40 sites are contaminated with high levels or radiation and dioxins across Iraq (see Figure 7). About 25% of these sites are near Iraq's largest towns and cities, including Najaf, Basra and Falluja. The Iraqi Minster of Environment indicated that 500 sites for chemicals and depleted uranium were investigated of which 42 had been declared as [high risk] both from uranium and toxins (Chulov, 2010). Some of the Iraqi officials told Chulov that they had informed the International Atomic Energy Agency that even if we have all the best science in the world to help us, none of the sites in Iraq could be considered to be clean before 2020.


*Figure 7: Contaminated sites in Iraq with DU (Chulov, 2010).*

*Figure 8: Inspection of radioactive military scrap.*

*Figure 9: Children playing with radioactive military scrap.*


*Figure 10: Military scrap yards in Iraq.*

Iraq is littered with expended munitions projectiles, DU destroyed equipment, broken random particles and wind showers of DU dust. Despite the danger and various hazards caused by DU

no serious action had been taken yet to clean these hazardous materials (Zankana, 2009). It should be mentioned however that United Nations environmental cleanup specialists asked U.S. and British officials for locations where the munitions were fired in Iraq, but they only reported receiving DU firing coordinates from Britain (Williams, 2008).

The aim of this project proposal is to execute a relatively cheap technique to burry contaminated radioactive military scrap in Iraq to save the civilians and the environment. This model can be executed in one site and then can be used in other sites.

## 6. Summary and conclusions

Iraq has suffered from DU ammunition which was used in the two Gulf wars in 1991 and 2003. More than 30 sites are contaminated with radioactive waste.

In addition, the material and equipment at the Iraqi Energy Authority sustained immense losses due to the turmoil and looting after the fall of the Baath regime in 2003. The same thing has happened to Iraqi Energy Authority, like all other Ministries and governmental organizations. The Middle East Media Research Institute (MEMI) in 2003 carried out an intensive interview with formal researchers at the Iraqi Energy Authority. They disclosed the events that took place at the facilities of the commission after the fall of Baath regime.

Tons of Uranium (as yellow cakes) as well as byproducts from processing activities in addition to tons of radioactive waste were stored in barrels. Simple citizens stole these barrels and used them for water storage.
All these events had severe consequences on human and the environment in Iraq. The rate of disabled born children has tremendously increased as well as the number of human's death due to cancer.
In view of the above it is of utmost importance to solve this crisis caused by radioactive waste. It is our strong belief that the existing waste should be buried and covered in a good scientific way to save the people of Iraq and their environment. The concept of designing landfills for hazardous waste partly already exists and can be developed further in order to fulfill the requirements for Iraq and the climate conditions in this country. Site selections for the landfills are important as well as landfill's sustainability in the very long time perspective. Here knowledge from the disposal of spent nuclear fuel can be used for obtaining a good design.

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